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BULLETIN

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TORREY BOTANICAL CLUB

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Vol. 51 No. 6

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JUNE, 1924

New Species of Mosses from the Malay Peninsula

H. N. Dixon

For some years I have been accumulating in my herbarium undescribed species from the East Indies, a number of them from Mitten's herbarium in The New York Botanical Garden. A large proportion of these were collected by Mr. H. N. Ridley and sent to Mitten for naming, but unfortunately remained undetermined at Mitten's death.

I have also received a considerable number of specimens of the same collector, some from Mr. Ridley himself, some from the Kew Herbarium, and others from the Singapore Botanical Gardens. The present paper deals with such of these as come from the Malay Peninsula.

The order and nomenclature followed are for the most part those of Brotherus in Engler & Prantl, Pflanzenfamilien.

Dicranaceae

Braunfelsia longipes Dixon sp. nov. (Plate 3, Fig. 1)

Species insignis, habitu *B. scariosae*, sed caulibus propter folia densissime conferta *turgidis*, *robustioribus*, usque ad 6 cm. altis, infra spadiceis, *apice stramineis*.

A *B. scariosa* quoque differt foliis *omnino enerviis;* a *B. enervi* foliis *longius*, *angustius acuminatis*, cellulis alaribus *magis rectangularibus*, (1.5–2 × 1); ab omnibus speciebus *seta longiore*, 2.5 cm. vel paullo ultra. Bracteae perichaetii pilo longissimo tenuissimo thecam aequante vel superante terminatae. Theca *B. scariosae*.

HAB. Gunong Tahan, Pahang, alt. 7000 ft., 1922; Mohammed Haniff and Mohammed Nur (7905).

[The Bulletin for May (51: 167–224) was issued June 13, 1924.]

Distinct from all the species in the long seta, and from all but *B. luzonensis* Broth. and *B. enervis* (Doz. & Molk.) in the nerveless leaves. The former differs in the small size, piliform leaves and short seta; *B. enervis* varies considerably in the form of the leaf-point; the leaf figured by Fleischer in the Musci der Flora von Buitenzorg, **1**: 95 being much more finely acuminate than as shown in the Musci Frond. Ined. Arch. Ind., Tab. III; the present plant has them still more finely and longly acuminate, while the seta is more than twice as long as usual in that species, though it may at times approach it in length.

Dicranoloma perintegrum Dixon sp. nov.

D. Billardieri (Schwaegr.) affine; differt foliis siccis inferne *plicatis*, superne *integerrimis*. Fructus ignotus.

HAB. Mt. Ophir, Malacca, Dec. 1898; Ridley (780).

In the absence of perichaetia and fruit it must not be too hastily assumed that this is a very close ally of *D. Billardieri*, but in the vegetative characters it could only be separated by those underlined above. The leaves are falcate-secund, the stems 6 cm. or more high. *D. braunfelsioides* Herzog from Ceram is near it, but has leaves and back of nerve somewhat toothed above, a narrow hyaline border to the leaf-base, absent here, and the leaves not falcate.

All the other Indo-Malay species differ in the leaves being toothed, apart from other characters.

Dicranoloma brevicapsulare Dixon sp. nov. (PLATE 3, FIG 2)

Stirps procerus, habitu *D. Braunii* vel formarum validarum *D. Blumii;* caules 10 cm. alti vel supra; folia valde patentia, sicca flexuosa, *haud falcata*, apicalia solum leniter falcato-secunda.

Folia *D. assimilis* fere, sed cellulis superioribus angustioribus, atque *limbo hyalino perangusto*, saepe obsoleto. Setae *singulares nec aggregatae* 2.5 cm. longae, eis *D. assimilis crassiores;* theca *multo brevior latiorque, deoperculata vix 3 mm. longa, turgide subcylindrica vel ab ore ad infra sensim angustata, leniter curvata*, subhorizontalis, basi *estrumosa;* peristomium magnum, intense rubrum.

HAB. Gunong Tahan, Pahang, 5500–7000 ft. alt., 1922; Mohammed Haniff & M. Nur (7915a).

All the allied species of the genus in this region are at once known by having the setae either aggregate or much shorter, or the capsule narrowly cylindric and distinctly strumose. In *D. sumatranum* Broth. the capsule is suberect, not arcuate, and more cylindrical, with a somewhat distinct neck. In the present plant there is no trace of struma, and very little of collum.

Thysanomitrium abbreviatum Dixon sp. nov. (PLATE 3, FIG. 3)

Habitu *T. exasperati*, sed caulibus siccis *turgide julaceis*, et propter folia multo breviora *subteretibus*. Folia eis *T. exasperati* similia sed breviora, apice latiora, obtusa, valde concava, nervo *omnino alieno*, basi 1/5–1/4 folii latitudinem aequante, *tenerrimo, plerumque unistratoso, cellulis 3–4-seriatis medianis tantum bistratosis, omnibus homogeneis*. Caulis unicus fructiferus vel masculus juvenis *T. exasperato* similis.

HAB. Summit of Gunong Tahan, Pahang, alt. circa 7000 ft.; Ridley (1012).

This and the following species are very remarkable; with nearly all the characters of *T. exasperatum* and *T. umbellatum* respectively, they present a nerve structure which is totally different, so much so as to suggest even a generic distinction. In those species, as is well known, the broad nerve, though thin, consists of at least three elements throughout the breadth, viz., a central layer of guide-cells, and both a ventral and dorsal layer of stereid ones, with occasionally outside these a slightly differentiated superficial layer of external cells. In the two species under consideration the nerve, while broad, consists for the greater part of its width of a single layer of small cells, scarcely distinguishable in section from those of the lamina (though quite distinct, owing to their form, from these when viewed from the front or back); the middle part of the nerve alone showing a double layer, but still of the same form of cells, and only extending for the width of three or four rows.

The leaves are shorter, more closely imbricated and appressed when dry, so that the stems are more terete and julaceous than occurs, unless very rarely, in *T. exasperatum*.

Thysanomitrium Ridleyi Dixon sp. nov. (PLATE 3, FIG. 4)

Praecedenti (*T. abbreviatum*) peraffine; differt tantum foliis *pilo longiusculo hyalino sublaevi* abrupte terminatis.

HAB. Gunong Tahan, Pahang, July, 1911; Ridley (1019b).

The stems of this plant are a little taller than in the specimen of *T. abbreviatum*, but there is no reason to suppose that this is a specific character. The sole difference lies in the constant presence of a distinct hyaline hair-point; otherwise the leaf form and structure, nerve, &c., are identical.

It stands therefore in the same relation precisely to that species that *T. umbellatum* (*T. Blumii* Nees) does to *T. exasperatum*, from which it only differs in the presence of a hair-point and in one or two very minor and perhaps doubtful characters. (The fringing of the calyptra, which is perhaps the chief distinguishing character given by Fleischer, is certainly of no real value, for I have more than once found in *T. umbellatum* capsules with calyptra both fringed and unfringed on the same tuft).

The two plants being described, therefore, give decided support to the opinion that I have elsewhere expressed that *T. exasperatum* may be only a muticous leaved form of *T. umbellatum*. There is, however, this difference, that while in *T. umbellatum* the leaves are acuminate at the apex, and taper gradually into the hair-point, in *T. Ridleyi* they are obtuse and cucullate, just as in *T. abbreviatum*, then passing abruptly into the hyaline point.

FISSIDENTACEAE

Fissidens subdiscolor Dixon sp. nov. (PLATE 3, FIG. 5)

§ Aloma. *F. discolori* Wils. ceylonensi affinis; differt caulibus *altioribus*, circa 1.5 cm. altis, foliis latioribus, *magis obtusis*, costa saepius ad apicem attingente; cellulis *minoribus*, 10–14 μ latis (*F. discoloris* 15–18 μ), et lamina dorsali *sat abrupte desinente*, *haud anguste decurrente*. Fructus subsimilis.

HAB. Gemas, Negri Sembilan, 1920, on root in a boggy hollow; Burkill (6388).

This may ultimately have to be united with the South Indian and Ceylonese species; but it differs in the larger size, the leaves nearly always rounded and obtuse at apex with percurrent nerve (In *F. discolor* the apex though often quite obtuse is frequently somewhat pointed, and the nerve generally ceases just below the apex); the cells also are decidedly smaller, and the dorsal lamina is not narrowed at the base as in that species.

Fissidens amblyotis Dixon sp. nov. (PLATE 3, FIG. 6)

§ Amblyothallia. Stirps subrobustus; caules 2 cm. vel ultra alti, rufi, crassiusculi, *stricti;* folia laxiuscula, *madida patentia pulchre plumosa*, sicca rigide decurvo-falcata, 1–1.5 mm. longa, lingulato-lanceolata, *breviter acuminata*, *subacuta*, integra vel apice subintegra; costa fuscescens, inferne valida, superne sensim angustata, saepe sinuosula, *infra apicem desinens*. Lamina vaginans vix dimidiam partem folii aequans, apice in *media lamina rotundate vel obtuse terminata;* lamina dorsalis ad basin sat abrupte desinens. Cellulae 9–13 μ latae, *incrassatae*, irregulariter ovoideae, laeves, pellucidae.

Fructus terminalis; seta perbrevis, circa 2 mm., theca parva, erecta.

HAB. On wet rock by stream, circa 700 ft. alt., Gunong Lambak, Johore, 1922; Holttum (9456).

The nearest species to this would appear to be *F. irroratus* Card. from Formosa, but from the description the cells in that species are smaller and of a different nature; while the obtuse termination of the vaginant lamina here, forming a sort of rounded auricle (whence the specific name) is a very distinct and unusual feature. It appears best placed in the Amblyothallia.

CALYMPERACEAE

Syrrhopodon Ridleyi Broth. in sched. (PLATE 3, FIG. 7)

§ Leucophanella. Inter *S. bornensem* et *S. rufescentem* ludens. Ab illo foliis siccis *apice plus minusve flexuosis, nec arcte imbricatis, angustius acuminatis;* ab hoc foliis siccis madidisque *haud reflexis*, cellulis chlorophyllosis *multo paucioribus*, pellucidioribus, *leniter tantum papillosis*, limbo latiore; ab utroque colore fuscescente vel sordide viridi, infra nec pallido nec rufescente.

HAB. On Platycerium, Bukit Timah, Singapore, 1908; Ridley (731). On large Platycerium, 2400 ft. alt., Government Hill, Pulau Penang, 1915; Burkill (763). Both fruiting.

Near to *S. bornense*, which also occurs on the peninsula, but quite distinct in the narrowly acuminate leaves and their arrangement. In *S. bornense* they are in the dry state erect and closely appressed, the leaf-point quite straight and unaltered by drying; so that the stems are more or less terete; in the present plant the upper part of the leaf or the apex only is distinctly

flexuose and not appressed, giving a totally different appearance under the lens. In *S. rufescens*, which is perhaps nearer, the leaves are rather abruptly bent back from the erect base, both moist and dry; the chlorophyllose cells there too reach much farther down the leaf, and are highly scabrous and opaque.

The type specimen is of a bright snuff colour above, and not much paler below; the Penang plant however is of a dull green; neither plant showing the very pale neat stems in the interior of the tufts characteristic of the two allied species, nor is the red colour often produced by the radicles in these at all pronounced here.

Syrrhopodon ligulifolius Dixon sp. nov.

Eu-syrrhopodon. § Tristichi. *S. Griffithii* Mitt. subsimilis, sed longe differt colore *rufo-fusco*, foliis *perstrictis*, e basi appressa rigide divaricatis, *siccis vix mutatis;* e basi perhyalina margine *fortiter anguste reflexo* cito in laminam *strictam, exacte ligulatam perangustam*, circa 80 μ latam, acutiusculam nec acuminatam contractis. Limbus marginalis *apicem attingens, ubique, nisi summo apice denticulato, integerrimus;* laminae cellulae fortiter papillosae, costa dorso *laevissima*.

Seta 1 cm. longa, tenuis; theca parva, deoperculata vix 1 mm. longa, elliptica, nitida, fusca.

HAB. Penara Bukit, Pulau Penang, 1896; Ridley (576).

Differs from *S. Griffithii* and others of that affinity in the extremely narrow, ligulate leaves, highly rigid, not at all crisped when dry, as well as in other characters. From *S. tristichus* and its allies it differs entirely in the small size, red colour, entire margin, &c.

Syrrhopodon elimbatus Dixon sp. nov. (PLATE 3, FIG. 8)

§ Eu-syrrhopodon. *S. spiculoso* Hook. & Grev. peraffine; differt autem foliis *longioribus*, 5–6 mm. longis vel paullo ultra, peranguste ligulatis, siccitate superne hamatis, colore (propter vetustatem?) fusco, lamina *omnino elimbata*, margine basilari *fortius spiculoso*.

HAB. Mt. Ophir, Malacca; Ridley (sine numero); herb. Mitten, ex herb. New York Botanical Garden.

Very near to *S. spiculosus*, but differs in the longer leaves, apparently in the colour, in the more strongly toothed border of the shoulder, and especially in the quite borderless lamina. In

S. spiculosus the hyaline border varies very greatly, and may be almost or quite obsolete here and there in a leaf; but it is always to some extent at least present. The basal part of the leaf here is perhaps narrower than in that species.

Syrrhopodon perakensis Dixon sp. nov. (PLATE 3, FIG. 9)

§ Calymperophyllum Fleisch. *S. Treubii* Fleisch. affinis, longe autem differt foliis omnibus multo *brevius, latius acuminatis*, margine basilari *integro*, cellulis *majoribus, multo pellucidioribus*, cancellina *multo breviore quam parte folii vaginante.*

HAB. Lumut Dindings, Perak, 1896; Ridley (449).

This plant belongs to a small Section of Syrrhopodon separated recently by Fleischer as § Calymperophyllum; the resemblance to certain species of Calymperes, notably of the § Calymperidium, renders the determination very perplexing. In these species, however, the thickening of the margin is usually intramarginal, so that the actual margin forms a sort of wing to the thickened border, while in the present species the margin itself is thickened; the cells however being of just the same character as those of the rest of the lamina, not being elongated nor incrassate. The lamina cells are larger (8–10 μ) and much more pellucid and distinct than in *S. Treubii*, and the leaves, especially the upper, "abnormal" ones much more shortly and broadly pointed. The sheath is narrow, very short, as in *S. Treubii*, about 1/5–1/4 the length of the leaf, and quite entire at margin, or only obtusely and sinuosely notched; the cancellina is only about half the length of the sheath, and the cells pass abruptly into the lamina cells. This is at variance with the character of the Section as defined by Fleischer, but the relationship of the species with *S. Treubii* is otherwise so close that I do not think it can be separated on that account. The cancellina cells decrease in width gradually from the nerve to the broad, narrow-celled border of the leaf-base.

Syrrhopodon pungens Dixon sp. nov. (PLATE 4, FIG. 17)

Thyridium. *S. undulato* (Doz. & Molk.) et affinibus comparabilis, sed gracilior, *multo rigidior, brunnescens;* rami 1–2 cm. alti, strictiusculi. Folia madida erecto-patentia vel patentia, sicca erecta subtorta apicibus horride patentibus; eis *S. undulati* similia sed apice in *cuspidem pungentem longam subtubulosam strictam acutam* producto.

Seta circa 1 cm. alta; calyptra angusta, basi subinflata, supra longe aciculata; theca erecta, 1.5 mm. longa (deoperculata), anguste elliptica, operculo longiore aciculari.

HAB. Petaling, Selangor, 1898; Ridley (772).

Nearest to *S. undulatus* and *S. Junquilianus*, but with a very marked difference in the leaf apex; the lingulate, undulate lamina quickly contracted into a straight, acute, narrow, subtubular, cuspidate acumen of varying length, frequently tipped, in the upper leaves, with gemmae. The hyaline border reaches usually to about the base of this acumen.

It is possible that it may prove to be a varietal form of *S. undulatus*.

Note on **Calymperes setifolium** Hampe.

Calymperes angustatum Broth. n. sp. in sched. Hab. Tapah, Perak, 1908; Ridley (149). This is certainly *C. setifolium* Hampe.

This species, and *C. aeruginosum* Hampe belong to a small Section of Machrimanta (consisting of two or three species only) having the leaves markedly constricted above the leaf-base and below the lamina, so as to form a sort of waist; this being especially noticeable in the upper, "abnormal" leaves, where the lamina cells are often reduced to an exceedingly narrow strip on either side of the nerve. Brotherus in his Key,—following Bescherelle—puts *C. aeruginosum* in a group with the margin at shoulder toothed. Bescherelle, it is true, describes the leaves as toothed in the upper part, and with the marginal cells at shoulder "dentiformes;" the latter character, however, is contrasted with "acute serratae" in *C. setifolium*, and does not imply, apparently, a high degree of dentation. But Hampe's specimens do not appear to bear out even this, and I am not able to explain the statement.

The figures of the leaf in Lacoste, Sp. Nov. vel Ined. Musc. Arch. Indici, Tab. V, show the leaf-base quite entire, and all the leaves I have examined of Hampe's type bear this out. In the present species (*C. setifolium*) the marginal and submarginal (perhaps representing the teniole) cells of the leaf-base remain elongated not only to the shoulder, but in a very narrow, 1–2 seriate border almost to the apex. The apical part of the leaf margin also is usually distinctly toothed, while in *C. aeruginosum* the leaf apex is quite entire or only very faintly toothed at the extreme tip.

Calymperes stenophyllum Dixon sp. nov.

Hyophilina. § Climacina. Humile; dense caespitosa. *C. hyophilaceo* et *C. Delessertii* affine; differt foliis superioribus *multo angustioribus*, e marginibus convolutis *subtubulosis*, nervo dorso infra *laevi*, supra sublaevi vel minute tantum scaberulo, cellulis superioribus laevibus.

Folii pars vaginans anguste obovata vel elliptica, tertiam partem folii longitudinem vel ultra aequans. Teniola nulla. Cancellinae cellulae *rectangulares*.

Ditissime fructiferum. Seta perbrevis, folia suprema haud superans. Calyptrae anguli supra fortiter serrulato-papillosi.

HAB. Lumut Dindings, Perak, 1899; Ridley (777).

Very near to the two species with which I have compared it, and to others closely allied, but with the leaves (except perhaps the very lowest) much narrower, tubular above, and the nerve nearly and often quite smooth at back. *C. hyophilaceum* and *C. Brotheri* Besch. have the cancelline cells quadrate. C. *eutrichostomum* C. M. I have not seen, but Fleischer states that it is only a narrow-leaved form of *C. Dozyanum*. *C. Delessertii* Besch. has distinctly wider leaves, and the back of nerve strongly papillose.

Calymperes constrictum Dixon sp. nov. (PLATE 3, FIG. 10)

Eu-calymperes. § Machrimanta. *C. setifolio* Hampe affine, folia latiora, medio *minus constricta*, apice latiore, integro vel raro indistincte distanter denticulato; teniola ad apicem fere, *limbum perangustum instruente*, circumdata; et parte basilari vaginante multo angustiore, sensim in laminam transeunte, margine superiore spinulis paucis sed fortibus armato.

HAB. Klang Watercatchment Forest, Selangor, on rotten bark on the ground, 1922; Burkill (6836).

The leaves in this species are only slightly constricted above the base, and it may therefore possibly not be so closely allied to the group of *C. aeruginosum* and *C. setifolium* as I have suggested. Moreover the leaves are closely enrolled when dry, and this is contrary to the habit of most of the species of this group; the cancelline here too is rather of the Climacina outline, the juxta-costal rows of its cells being the longest, while in the two species referred to the median rows are the longest, giving the cancellina a rounded summit. The cancelline cells too are

rather longer, those of *C. aeruginosum* and *C. setifolium* being sub-quadrate. The toothing of the marginal shoulder is different from that of *C. setifolium*, the upper teeth being few, and markedly rigid and spine-like, with a few much smaller ones lower down. The marginal cells of the base form a broad, pale border quite to the shoulder, which gradually narrows from there into the very narrow, thickened border of the lamina.

Whatever its exact relationship be, it is a very distinct species.

ORTHOTRICHACEAE

Macromitrium magnirete Dixon sp. nov.

§ Leiostoma. *M. Zollingeri* forsan affine. Sat robustum, dense intricatum, fuscum; caules densissime ramosi, ramis inaequalibus, .5–1 cm. longis, foliis densissime confertis, siccitate inferioribus laxiuscule, apicalibus arcte spiraliter contortis, madidis patentibus. Folia circa 1 mm. longa, oblongo-lanceolata, e medio ad apicem acutum vel subobtusum angustata, costa excurrente longiuscule cuspidata; costa ad basin sat valida, profunde carinata, supra multo angustior; margine integro, basi uno latere reflexo. Cellulae *magnae*, 12–18 μ latae, *mamillosae*, ovales, *perincrassatae*, infra sensim elongatae, basilares angustissime lineares, rectae, grosse tuberculatae. Seta circa 1.5 cm., laevis. Theca minuta, elliptica, laevis, microstoma. Calyptra laevis. Peristomium *externum nullum;* internum membrana altiuscula albida.

HAB. Gunong Tahan, Pahang, 7000 ft., 1922; Mohammed Haniff and M. Nur (7907).

Nearest to *M. Zollingeri* and *M. Blumii*, but differing in the larger, highly mamillose cells, more acute leaf apex, and apparently in the peristome, which in both these species is double. The numerous capsules I have examined of the present plant show no trace of outer teeth, although some of them are in quite good condition; they are, however, all past maturity; and it is quite possible that the outer teeth may have been lost.

MYURIACEAE

Myurium subnitens Dixon sp. nov.

Sat gracilis, statura *M. sinici* Mitt. vel *M. quinquefarii* Thér., sed ramis *longioribus*, *flexuosis*, *densissime caespitosis*, pallide fusco-viridibus, breviter cuspidatis *haud vel vix nitentibus*.

Folia conferta, imbricata, perconcava a basi cordata late ovato-orbicularia, cucullata, abrupte in acumen circa ½ longitudinem folii aequans, loriforme, acutissimum fortiter denticulatum contracta, ecostata; marginibus toto ambitu superiore argute tenerrime denticulata. Cellulae superiores sinuato-rhomboideae, parietibus incrassatis porosis sed tenerrimis, ideo cellulae velut conflatae; basilares angustiores, infimae saepe aurantiacae, alares nonnullae aurantiacae, subinflatae, auriculas parvas bene notatas instruentes. Cetera ignota.

HAB. Sempang, Fraser Hill, Pahang, 1911; Ridley (282).

With the leaf form and structure of *M. rufescens*, but more slender than any of its forms and without the glossy texture of that species; the leaf-point also is wider and more rigid than is usual there; the dense habit is also characteristic.

NECKERACEAE

Endotrichella plano-marginata Dixon sp. nov.

E *minoribus generis;* caules 3–4 cm. alti, densifolii, foliis patulis, frondes 4–5 mm. latas formantibus; folia *late cordato-ovata*, 3–3.5 mm. longa, 2 mm. lata, apice *raptim in cuspidem brevem, latam, fortiter dentatam* contracta, plicata, marginibus *omnino plania*, superne magis magisque fortiter denticulatis; costae nullae; cellulae *parvae*, superiores 40-55 μ longae, lumine 5–8 μ lato, parietibus incrassatis; basilares elongatae, angustae, alares numerosae, multo latiores, subquadratae, pellucidae, *alas minusculas conspicuas* instruentes.

Fructus ignotus.

HAB. Batu Caves, Selangor, 1896; Ridley (472). Base of a large tree in jungle, Sekong, Brit. North Borneo, 1913; Binstead (185).

The generic position of this species in the absence of fruit must remain doubtful, but whether it be an Endotrichella or a Garovaglia it is a distinct new species. Very few of the species of these genera have the leaf margin plane, and from those with this character the small size, small rounded leaves, small cells, conspicuous alar cells, and sharply toothed robust apiculus will separate it without difficulty. *Garovaglia aristata* is perhaps the most like it, but has finer, quite entire apiculus; while *G. densifolia* Thw. & Mitt. has almost entire leaves and much larger cells.

Pinnatella lingulata Dixon sp. nov. (PLATE 3, FIG. 11)

P. liguliferae (Lac.) Fleisch. affine, sed *frondibus et foliis percomplanatis*, atque foliis siccis minute transverse rugosis, siccitate quoque leniter longitudinaliter biplicatis; sine ullo limbo intramarginali.

Frondes oblongae, bipinnatae; folia stipitis *suberecta, haud reflexa*, caulina e basi latiore uno margine late inflexo concava, *late oblongo-lingulata*, apice rotundato et breviter acuto, integro vel minutissime crenulato, marginibus planis; costa infra valida, apice cito angustata ibidemque saepe bifurcata, *longe infra folii apicem desinens;* cellulae superiores minute ovato-hexagonae, incrassatae, dorso laeves, marginales magis elongatae, omnes basin versus longiores, basilares lineares. Folia ramulina minora, paullo acutiora.

Fructus in parte superiore caulis et in ramis superioribus situs; seta 1 mm. longa, laevis; theca subaequilonga, elliptica, brunnea, operculo curvato rostellato; peristomium majusculum, pallidum.

HAB. Growing horizontally on upright tree-trunks, Gunong Tampin, 1800 ft. alt., Negri Sembilan, 1917; Burkill (2864).

A rather marked species in having the leaves and branches very complanate, the marginal cells slightly elongate, and smooth. *P. Kuhliana* differs in the reflexed leaves of the stipes, smoother, more pointed, more ovate, concave leaves, and very different cells; *P. ligulifera* Fleisch. in the not or less complanate habit, and other points.

The transverse rugulosity of the leaves is minute, and best seen under the microscope, but is quite evident with the lens in the dry state.

ENTODONTACEAE

Clastobryum prionotrichum (Hampe in sched.) Dixon sp. nov. (PLATE 3, FIG. 14)

Caules secundarii brevissimi, dense caespitosi, gracillimi, fusci (? propter vetustatem), saepe *ramos flagelliformes microphyllos tenuissimos* emittentes. Folia imbricata, erecto-patentia, vix .5 mm. longa, e basi angustiore ovalia; *in acumen flexuosam subulatum subaequilongum argute denticulatum sat cito angustata;* ecostata, pellucida, concava; cellulae anguste lineares, perpel-

lucidae, prosenchymaticae, laeves, parietibus tenuibus, infra medium folium vix mutatae, ad angulis plures magnae, vesiculosae, hyalinae, alas optime notatas triangulares instruentes. Cetera nulla.

HAB. Nullonng, 7000 ft., Burma; Kurz (2863).

This plant was sent to me from Mitten's Herbarium at The N. Y. Botanical Garden, as *Hypnum prionotrichum* Hampe ined. It seems to belong clearly to Clastobryum, but is very distinct from the published species in the oval leaves rather abruptly narrowed to a fine, flexuose, toothed subula, and in the large, vesicular, thin-walled alar cells, ascending in 2–3 series of smaller ones at margin. The microphyllous flagella are also noteworthy; a somewhat allied species from Assam (*C. surculare* Dixon ined.) has similar branchlets, but more shortly pointed leaves and small alar cells.

HOOKERIACEAE

Chaetomitrium setosum Broth. in sched. (PLATE 3, FIG. 13)

Sat robustum, habitu *C. philippinensi* subsimile; dense ramosum ramulosumque; folia *sat distincte seriata, stricta,* 1.5–2 mm. longa, oblongo-ovata, *cochlearia,* infra acumen breve acutum reflexum constricta; costis binis brevibus *bene notatis,* marginibus inflexis, e medio folio *sensim argutius denticulatis, parte superiore saepe spinulose dentatis;* cellulae perangustae, dorso *alte argute papillosae.*

Perichaetii bracteae foliis subsimiles, angustiores, minus concavae, longius acuminatae, fortius spinulose dentatae; seta circa 5 mm. alt. per totam longitudinem fere *dense praealte setosa.* Calyptra basi longe laciniata, ciliis flexuosis, e cellulis *pluriseriatis* compositis. Theca horizontalis.

HAB. Tapah, Perak, 1908; Ridley (169).

A quite distinct species, with somewhat the habit of *C. philippinense* and *C. elongatum,* but with a highly setose, short fruit-stalk. The deeply concave leaves, with the upper part of the inflexed margin often very sharply toothed, also give marked distinguishing characters.

Chaetomitrium perakense Broth. in sched. (PLATE 3, FIG. 12)

C. orthorrhyncho proximum, nec differt nisi caracteribus fructiferis; perichaetii bracteae *haud ciliatae, sed fortiter runcina-*

tae, dentibus plus minusve recurvis; seta *ad basin fere tuberculata*.

HAB. Bidor Tapah, Perak, 1908; Ridley (sine numero).

The inner perichaetial bracts in *C. orthorrhynchum* are longly ciliate-fringed in the upper margin, while here the margin—like the subula—is runcinately toothed; the lower part of the seta is in that species smooth, while here it is warted almost or quite to the perichaetium. I find no difference in the gametophyte.

HYPNACEAE

HYLOCOMIEAE

Ctenidium falcifolium Dixon sp. nov.

Laxe caespitosum, *flavo-aureum, sat robustum*. Caulis repens, ad 3 cm. longus, plusminusve *regulariter, nonnunquam dense pinnatus*, ramis circa .75 cm. longis, apicem versus caulis sensim decrescentes. Folia haud valde conferta, *plerumque falcato-decurva, flexuosa;* caulina e basi anguste oblonga sensim in subulam longam piliformem fortiter argute dentatam, saepe tortam, angustata. Folia ramea similia sed angustiora. Cellulae perangustae, longae, dorso *laeves, per totum folium fere uniformes*, basilares haud laxiores, alares vix ullae, ad angulos extremos tantum 1–2 parvae, hyalinae.

Perichaetium majusculum, foliis internis *longis*, patentibus, *sensim longe subulatis*, argute dentatis. Seta circa 1 cm. alta, *tenuis*, laevis; theca *parva*, 1 mm. longa, inclinata, oblonga, gibbosa, sub ore constricta; ad basin in setam abrupte contracta. Operculum, calyptra, ignota.

HAB. Thaiping Hills, Perak, 1903; Ridley (817).

A little obscure as to position, having some title to be considered a Stereodon rather than a Ctenidium. The general foliation, the coarsely toothed leaves, turgid capsule, &c., however, rather suggest Ctenidium. It is quite distinct from its allies in the falcate, narrow leaves without angular cells, and small capsule, with the exception of *C. stereodontoides* Dixon from South India, which has much the same habit and leaf form and structure. The colour there, however, is green, not golden, the leaves are far less sharply toothed, with more numerous and distinct alar cells.

STEREODONTEAE

Ectropothecium singapurense Dixon sp. nov.

Dioicum. E robustioribus generis, habitu *E. buitenzorgii* et *E. Dixoni* Fleisch. simile; caules elongati, *densissime pinnatim ramosi*, ramis 5–7 mm. longis, crassiusculis, *haud complanatis*. Folia *confertissima*, fortiter falcata vel hamata, *magna*, circa 2 mm. longa, ad basin 1 mm. fere lata, leniter plicata; e basi lata subdeltoidea in acumen subulatum falcatum subintegrum vel tenuiter denticulatum angustata, margine prope apicem plerumque *leniter anguste reflexo;* ecostata. Cellulae pro folii magnitudine *parvae, breviusculae, angustissimae, basin versus paullo latiores*, infimae tantum *hyalinae*, tenues, *alas decurrentes conspicuas*, majusculas instruentes.

Folia ramea minora, angustiora, latius acuminata, magis denticulata; cellulae superiores *dorso tenuissime scaberulae.*

Cetera nulla.

HAB. In grass in open, Botanical Gardens, Singapore, 1913; Binstead (78).

One of a group of closely allied species, differing, however, in quite sufficiently marked characters. *E. Dixoni* Fleisch. has much longer, smooth cells, and more strongly toothed leaves. *E. goliathense* Fleisch. from New Guinea has longer branches and much larger cells. *E. buitenzorgii* differs entirely in the basal areolation.

Hypnum malaccanum C. M. in sched.; Penang, 1896, leg. Curtis, cannot be separated from *Ectropothecium buitenzorgii* (Bél.) Jaeg.

Ectropothecium callichroides (C. M.) Jaeg.

elongatum Dixon var. nov. (PLATE 3, FIG. 15)

Caules *haud dense caespitosi, elongati*, 7 cm. longi vel ultra, *conferte regulariter pinnati*, ramis subaequalibus, 4–5 mm. longis.

HAB. Rawang, Selangor, 1896; Ridley (382). Gunong Raya, Lankawi Islands, 1921; Mohammed Haniff & M. Nur (7134).

E. callichroides was so named from its resemblance to *Hypnum callichroum* (Brid.), and like that usually grows in densely interwoven tufts, the stems being difficult to separate. In this variety the stems are not intertwined, but grow loosely, and are

very regularly pectinate with short branches throughout their length.

E. callichroides has not been recorded from the mainland of Asia; its distribution has hitherto been the Philippines and Borneo.

It was described from sterile plants, and the fruit has, so far as I am aware, not been found. Perichaetia are present in the Lankawi Islands specimen; these are large, with long, spreading, rigidly loriform-subulate leaves, denticulate at the tips.

Ectropothecium siamense Dixon sp. nov. (PLATE 3, FIG. 16)

Dioicum videtur. *E. scaberulo* Broth. (*E. incubans* f. *scaberula* Fleisch.) forsan affine; mediocriter robustum; caules regulariter pinnati, ramis circa 5 mm. longis, percomplanatis; sordide viride; folia valde patentia, minuscula, circa .75 mm. longa, *valde complanata, nec curvata;* caulina e basi ovata sensim breviter argute acuminata, ramea ovata, *late breviter acuta;* omnia margine plano, *e basi fere breviter, densissime serrulata;* cellulae *parvae, laeves,* foliis caulinis medianae breviter lineares, marginalibus una serie brevioribus; omnes granulosa ideo subopacae, ad angulos paucae laxiores pellucidae, alas minimas, sat notatas formantes; areolatio foliorum rameorum sat similis sed omnes cellulae breviores, apicales *latiores, ovato-rhomboideae.* Cetera ignota.

HAB. Khan Poi Hill Kasum, Siam, 1898; Mohammed Haniff & M. Nur (3919).

There is a close resemblance between this plant and *E. scaberulum* Broth., which Fleischer considers a form of *E. incubans* (Reinw. & Hornsch.). This is enhanced by the cell ends appearing punctate under the microscope, as if projecting; they are however entirely smooth; the shortly pointed branch leaves, the rather opaque, short cells, and especially the very regularly and closely serrulated margins distinguish it from all the species I know except an unpublished species I have in my herbarium from New South Wales.

It was growing closely associated with fruiting *Taxithelium nepalense.*

Ectropothecium Moritzii (C. M.) Jaeg.

stereodontoides Dixon nov. var.

Pernitidum, albescens; folia ramea caulinis similia, *angusta, valde falcata, sensim subulata,* cellulis pellucidioribus.

HAB. Fraser Hill, Pahang, 4000–4370 ft. alt.; Burkill & Holttum (8715d). Also, same locality, on log in jungle, at 4000 ft.; Holttum (11375).

E. Moritzii is said by Fleischer to be a rare species in Java, and I have no Javan specimens in my herbarium. It is however a common plant in Borneo, and on the Malay Peninsula, and I have numerous specimens from both of these parts. While easily recognized they show a considerable amount of variation in the leaf form and direction, as well as in the degree of glossiness. One form especially has the branch leaves very different from those of the typical plant as figured in the Bry. Jav. (though it is referred to by the authors in their diagnosis—"ramulina similia vel oblonga, brevius acuminata"), being almost straight, and complanate, scarcely or not at all falcate or decurved, widely spreading, very shortly and sometimes quite widely pointed; in this case they are usually brown, scarcely at all glossy, with shorter, opaque cells and the marginal row especially short and markedly differentiated. The plant is in this case very markedly different from the type (so much so that an extreme form of it (Singapore, Ridley, No. 203) has been named *Chaetomitrium Ridleyi* Broth, MS. in sched. !); as a rule however some branches show the more normal form of leaf, and—together with the fruiting characters—establish identity with *E. Moritzii.*

E. Moritzii is described in the Bry. Jav. as "nitidula," by Fleischer as "wenig glanzend." This description is applicable to the usual forms, though here and there a plant, or part of a plant, shows a decided gloss. In the present variety the branch leaves are exceedingly glossy, and in their extreme form of a pale or quite white colour; they are much narrower than usual, and strongly decurved-falcate, with fine, subulate or almost filiform points; the areolation is much more pellucid, of longer cells, with the marginal cells not or scarcely differentiated. The first specimen I received of the variety showed only a few sterile scraps mixed with Trichosteleum, &c., and showed no resemblance whatever to *E. Moritzii;* it was in fact, to all intents

and purposes a Stereodon, but it showed such an almost absolute resemblance to a South Indian species of Ctenidium recently described by me as *C. stereodontoides* that I gave it the MS. name of *Ctenidium substereodontoides;* and I had indeed actually drawn up a description of it for this article under that name, when a further consignment of mosses from Fraser Hill threw a quite unexpected light upon it. A large tuft of more or less typical *E. Moritzii* showed here and there a branch entirely identical with the new species, and I was able to find here and there a stem having some or most of the branches bearing the short, shortly pointed, complanate, brown leaves, other branches being typical, but here and there a single branch with all the "stereodontoid" characters of the present var. clearly marked (one had in fact on a single stem, *Ectropothecium Moritzii*, *Chaetomitrium Ridleyi*, and *Ctenidium substereodontoides*!). Further examination showed some stems with all the branches exhibiting the varietal characters, and one or two of them were fruiting. Others in the same tuft were nearly typical, and some quite so: and it is difficult therefore to draw a clear line between the variety and the type; but the extreme form being so marked and so deceptive, it seems desirable to characterize it and perhaps avoid future pitfalls by separating it as a variety.

PLAGIOTHECIACEAE

Taxithelium instratum (Brid.) Broth.

Kurzii Dixon. nov. var. (Hypnum microcladum Hampe MS. in herb. *Trichosteleum Kurzii* Sanesb.; Jaeg. Adumbr. II, 480 *nomen*).

A forma typica cellulis *minus dense, magis irregulariter papillosis* solum differt.

HAB. Yomah, Pegu; Kurz (2922).

This plant was distributed as *Hypnum microcladum* Hampe MS. (or sometimes, erroneously as it seems, as *H. microcladum* C. M. MS.). It must not be confused with *H. microcladum* Tayl. & *H. microcladum* Doz. & Molk., both of which belong to Rhaphidostegium.

It is scarcely to be distinguished from *Tax. instratum*, only the leaves are less densely, less regularly papillose.

Taxithelium isocladioides Dixon sp. nov. (PLATE 4, FIG. 1)

T. isoclado (Bry. Jav.) affine atque simile, differt foliis *angustioribus, perfecte lanceolatis* nec ovato-lanceolatis, *longius argutius acuminatis*, sat *fortiter denticulatis*, cellulis majoribus, *tenerrime, saepius indistincte* seriatim papillosis. Cetera ut in *T. isoclado*.

HAB. Bujong Malacca, Perak, 1898; Ridley (737) in herb. Mitten.

With the habit and fruiting characters of *T. isocladum* (so far as seen) this differs quite markedly in the much narrower and more narrowly acuminate leaves, the sharply denticulate margin, and the larger, pellucid cells, only very minutely and usually quite indistinctly papillose. In fact it might easily be mistaken for an Isopterygium.

Taxithelium trachaelophyllum (C. M. in sched.) Dixon sp. nov. (PLATE 3, FIG. 17)

T. Gottscheano Hampe forsan proximum; differt foliis rameis *percomplanatis, perfecte rotundato-obtusis*, rarissime latissime subacutis; cellulis *indistincte, minutissime, humillime papillosis*, alaribus *majoribus*, elongatis, incrassatis, saepe aurantiacis.

Fructum haud vidi.

HAB. Yonah, Burma; Kurz (3332).

This was determined as *Hypnum trachaelophyllum* C. M., but has not been published. It is nearest to *T. Gottscheanum* Hampe and *T. capillipes*, both of which differ in the more pointed leaves, and the smaller and less distinct alar cells, while *T. Gottscheanum* also has the cells quite distinctly seriate-papillate; in the present plant the papillae while present and seriate, 3–4 on a cell face, are extremely low and often quite indistinct and with difficulty seen.

Taxithelium subtrachaelophyllum Dixon sp. nov. (PLATE 3, FIG. 18)

T. trachaelophyllo (v. supra) affine; foliis autem *angustioribus, apice minus rotundatis*, cellulis *duplo majoribus*, parietibus *firmioribus* (eis *T. trachaelophylli* pertenuibus), alaribus *minoribus*, paucioribus; papillae perindistinctae, tenerrimae, 2–4 seriatae.

Bracteae perichaetii in acumen subrectum *rigide late loriforme* nec subulatum, subdenticulatum angustatae. Seta circa

2 mm. alta. Theca parva, elliptica, collo in setam defluente, *erecta vel suberecta*.

HAB. Borneo, Motley. Krangi, Singapore, 1895; Ridley (695). Suli Archipelago, 1898; Burbidge, Bukit Timah, Singapore, 1896; Ridley (692, 693).

This is intermediate between *T. trachaelophyllum* and *T. sumatranum;* it differs from the former in the characters detailed above, especially in the quite different cells; *T. sumatranum* has more acute, pointed leaves, and the papillae almost wanting; the inner perichaetial bracts also are much more finely subulate and flexuose.

The papillae vary greatly, being at times wanting, at others very faint and scarcely to be detected except with great care, and at others quite well marked; they vary from 1–2 on each cell surface to 3–4.

Taxithelium bilobatum Dixon sp. nov. (PLATE 4, FIG. 2)

Subgen. Anastigma. Species praeclara. Habitus *T. instrati*, caulibus ramisque *valde complanatis*, substrato arcte adpressis; (vetustate) fuscis. Folia octofaria, *heteromorpha;* ea serierum quattuor ventralium et dorsalium late oblonga, apice *rotundato*, obtuso, concava, ecostata, marginibus fere e basi *arcte denticulatis*, apice denticulis confertissimis irregularibus saepe recurvis quasi erosa. Cellulae breviter sinuoso-lineares, laeves, serie marginali *breviores, pellucidiores;* basilares infimae breviores, latiores, alares *nullae*.

Folia serierum quattuor lateralium majora, *perconcava, seu lobis duobus conduplicata, quorum uno minore breviore, altero majore longiore; a sinu plus minus profunde sejunctis; areolatio* et marginum denticulato ut in foliis dorsalibus et ventralibus.

Perichaetium *breve, turgidiusculum*, bracteis e basi latiore *breviter late* acuminatis, nec multo attenuatis, irregulariter dentatis, erecto-patentibus. Seta 2 cm. vel paullo ultra; theca (immatura) parva, brevis, basi in setam defluens; inclinata, operculo rostellato.

HAB. Bujong Malacca, Perak; Ridley (739), in herb. Mitten.

A very remarkable species, with the lateral leaves more distinctly bi-lobed than in any other moss that I know. It is most nearly allied to *T. glossoides* (Bry. jav.), and the dorsal and ventral, undivided leaves are very similar to those of that species, but the lateral leaves are entirely different.

SEMATOPHYLLACEAE

Acanthocladium polymorphum Dixon sp. nov. (PLATE 4, FIG. 3)

A. surculari Mitt. affine, statura autem robustiore. Stirps habitu, ramificatione, foliorum forma et structura valde polymorpha; caules 5 cm. longi vel ultra, nunc flexuosi, irregulariter brevissime pinnatim ramosi, nunc dense pinnati ramis strictis, .75–fere 1 cm. longis, obtusis vel breviter attenuatis *nunquam flagelliformibus*. Folia caulina eis *A. surcularis* simillima, e basi *latissime, oblongo-ovata in pilum subaequilongum flexuosum integerrimum* subito contracta, ecostata; areolatio perdensa, e cellulis angustis lineari-flexuosis laevibus, parietibus tenuibus, basin versus sensim paullo majoribus, latioribus instructa; alaribus 3–4 *magnis, elongatis, vesiculosis*, pulchre aurantiacis, supra-alaribus nonnullis multo minoribus, hyalinis vel aurantiacis.

Folia ramea *polymorpha*, nunc anguste ovato-lanceolata, longe tenuiter subfiliformiter acuminata, integra vel subintegra, nunc breviter late acuminata marginibus ad apicem reflexis, denticulatis, nunc late ovata, breviter late acuminata vel tantum acuta, marginibus ad acumen valde recurvis, argute, fortiter dentatis. Areolatio *diversa*, foliorum angustiorum e cellulis elongatis, linearibus vel anguste rhomboideo-linearibus, latiorum e cellulis brevioribus, latioribus, ovoideo-rhomboideis, instructa; cellulae aut omnino laeves, aut hic illic unipapillosae, aut, praecipue eae foliorum latiorum, unaquaque papilla magna alta medio lumine praedita.

Dioicum. Perichaetium *polyphyllum*, foliis erectis, sensim in subulam strictiusculam subintegram vel denticulatam angustatis. Seta (unica imperfecta) crassiuscula.

HAB. N. W. slopes of Mt. Mooleyit, near Moulmein, Tenasserim. Comm. W. R. Sherrin.

A remarkably polymorphous plant, as described above, the leaves of the branches being of such diverse form and structure, as to make it very difficult to believe that they all belong to one species, the margins being plane or strongly recurved above, entire or strongly, coarsely toothed, the cells sometimes narrowly linear and ten or more times as long as wide, at others ovate-rhomboid and not more than three or four times as long as wide; I have seen branches with all the cells quite smooth,

others with all the leaves highly and densely papillose, and others in which they are all smooth but a few here and there slightly papillose. It is a very perplexing, but a quite distinct species. *A. surculare* Mitt. has the branch leaves scarcely toothed and smooth, and most of the branches attenuated to a caudiform apex.

Trichosteleum brachypelma (C. M.)

compactum Dixon var. nov.

Caespites humiles, *densissimae;* folia complanata, strictiuscula; folia ramea atque perichaetialia *brevius acuminata.*

HAB. Garden jungle, Singapore, 1894; Ridley (321).

Trichosteleum brachypelma appears to be a rather widely distributed plant; sometimes scarcely differing from *T. Boschii* except in the smooth seta; but often with more gradually tapering leaves and less papillose cells. These characters are evident here, but in addition the tufts are extremely compact, the leaves complanate and less flexuose, often very shortly and even widely pointed.

Trichosteleum albifolium Dixon sp. nov. (PLATE 4, FIG. 4)

Inter *Taxithelium papillatum* intertextum, dense compactum, habitu *Tr. singapurensis*, &c.; *albidum, pernitidum;* caules irregulariter ramosi, ramis inaequalibus, *percomplanatis, strictis;* folia rigide complanata, e basi subamplexicauli, contracta, patentia, ovato-lanceolata, *breviter anguste acuminata*, integra; folia ramea minora, angustiora, brevius latius acutata, apice subdenticulato; omnia ecostata; cellulae anguste lineares, parietibus *angustis, indistinctibus; omnino laeves;* alaribus 2–3 magnis, hyalinis, vesiculosis.

Perichaetium magnum, polyphyllum, foliis suberectis, *sensim in subulam rectam haud flexuosam* denticulatam angustatis. Cetera nulla.

HAB. On fallen tree in forest, seventh mile from Kluang, Mersing, Johore, 1922; Holttum (9296b).

Quite distinct in the very white, glistening, shortly pointed leaves, and quite smooth cells, though otherwise in habit and leaf form resembling several other species, e. g., *T. singapurense* Fleisch. It grew closely mixed up with a form of *Taxithelium papillatum* in fruit, but none of the fruit appears to belong to

the *Trichosteleum*. *T. singapurense* has besides the papillae much longer leaf points. The leaf form and alar cells show it not to be an Isopterygium. Unfortunately the quantity is very small.

ACROPORIUM Mitt.

The genus as understood here includes the species of Sematophyllum as employed by Brotherus, with the exception of a small group of autoicous species of the Section Chaetomitriella, which appear to me better placed in Trichosteleum. American writers usually retain the arrangement of the Musci Austro-americani, i.e., they include under Sematophyllum all the species of Acroporium and also those separated by most recent authors (Jaeger, Brotherus, etc.) as Rhaphidostegium. Fleischer, on the other hand, in his recent work distributes the Javan species of the aggregate genus over ten different genera. I must confess that on the whole I prefer—with a few slight exceptions—the middle course kept by Brotherus, especially as concerns the keeping apart Rhaphidostegium and Sematophyllum. United they form a very unwieldy genus, at least 400 species having been described in the two Sections; while Rhaphidostegium, if not easy to separate by well defined structural characters, is so distinct in habit that so far as I know there has never been any doubt as to the position of any species of the whole 400 or so as to the group in which it should be placed, with the possible exception of two—*R. saproxylophilum* (C. M.) being placed among species of Acroporium in the Bry. Javanica, and *R. Schwaneckeanum* (C. M.) having been placed—for some obscure reason—in Pungentella (i. e., Acroporium) by C. Mueller himself in Hedwigia, 1898.

As regards the name, I think it is clear that Fleischer is correct in restoring Mitten's name Acroporium, in the place of Sematophyllum, the name retained by Jaeger, Paris, and Brotherus.

The genus Acroporium was validly published by Mitten in his List of Samoan Mosses in Journ. Linn. Soc., Bot., x, 182 (1868), and the diagnosis makes it clear that it is used in the restricted sense, not including the species often placed in Rhaphidostegium, and already separated from Hypnum (or Stereodon) by Mitten in 1864.

Sematophyllum Mitt. was validly published in Journ. Linn. Soc., viii, 5 (1864), for *S. auricomum* sp. nov., which is found identical with *Hypnum substrumulosum* Hampe; and this must be considered the type of the genus. Neither in that paper nor till 1869 did Mitten unite the two groups.

Sematophyllum Mitt. does not date from the Musci Austro-americani, Journ. Linn. Soc., Bot., xii, 20 (1869), as stated by Paris, nor, as it is given by Jaeger, from 1868. Jaeger wisely attempts no closer reference than "Journ. Linn. Soc. 1868," relying, no doubt, on Mitten's note on p. 474 of the M. Austr.-amer., "Sematophyllum, Mitt. in Journ. Linn. Soc., 1868." This, however, is a false reference. The only paper of that year that could be referred to is Mitten's List of Samoan Mosses, in Journ. Linn. Soc., Bot., x (1868) where Mitten founded his genus nov. Acroporium, but where Sematophyllum is not even mentioned. Mitten wrote 1868 either by error for 1864, or, wishing to widen his genus Sematophyllum (to include the species of Acroporium), he referred to the 1868 paper, but should have cited Acroporium, instead of implying that Sematophyllum was there used.

Clearly therefore Acroporium is the correct name to be used for the present group of species by those who keep the two groups separate; while Sematophyllum is the earliest name for the species of Rhaphidostegium (Schimp.) De Not. For those who still unite them the correct name would be Sematophyllum Mitt. (1864) emend. Mitt. 1869.

Fleischer has found that several of the names used in the Bry. Jav., and subsequently employed by authors under Sematophyllum are antedated by earlier valid names, especially of Reinwardt and Hornsch., and these of course must be restored. It may save trouble if I give here these equivalents for the more familiar specific names.

Bry. Jav.	Fleischer
Hypnum scabrellum Lac.	*Acroporium lamprophyllum* (*Mitt.*)
H. gracilicaule Lac.	*A. diminutum* (Brid.)
H. Braunii C. M.	*A. rufum* (Reinw. & Hornsch.)
H. strepsiphyllum Mont.	*A. secundum* (Reinw. & Hornsch.)
H. hyalinum Reinw.	*A. stramineum* (Reinw. & Hornsch.)

The exceedingly interesting genus Acroporium has its centre in the Indo-Malayan region. Of 75 species included by Brotherus in the "Musci," 42 occur in this region (including New Guinea), and are indeed confined to it; as compared with 13 in Africa, 12 in Oceania, and 8 in America. Since the publication of that work at least a dozen new species have been described in the area; the present paper describes 11 additional ones, and I have two or three further undescribed ones from Borneo, in my herbarium. Probably 60%, therefore, of the species belong to this region, very few of them, or indeed of any species of the genus having at all a wide range.

Acroporium serrulatum Dixon sp. nov. (PLATE 4, FIG. 5)

A. cuculligero (Bry. Jav.) proximum; minus; rami breviores, nec attenuati, nec gemmipari; foliis paullo latioribus, e basi fere *conferte serrulatis;* areolatio *pellucida*, nunc laevis, nunc dorso sparse papillosa, e cellulis *multo brevioribus minoribus*, parietibus *incrassatis;* bracteae perichaetii suberectae, sensim in subulam haud flexuosam, *densissime, argute serrulatam, fere spinulosam*, angustatae.

Seta plusminusve 1 cm., *crassiuscula*, superne *humillime* ruguloso-papillosa; theca paullo *major*, inclinata vel horizontalis, operculo rostello *longiore*, deflexo.

HAB. Penang Hill, Pulau Penang, 1898; Ridley (750). Ibidem, 1896 (547).

This very pretty little plant is very close to *A. cuculligerum*, and would be placed by Fleischer in his new genus Clastobryella. It differs however quite markedly from that species in several respects. The cells in *A. cuculligerum* are thin-walled, but owing to the cell contents are not translucent, and the leaves always have a rather opaque appearance. Here the cells are much smaller, and thick-walled (the lumen being only about the width of the adjoining wall) especially at the cell ends; but both wall and cell being translucent the leaf is quite pellucid. The alar cells are pale, two or three on each side, and not occupying a large proportion of the width of the base.

The margin in *A. cuculligerum* is acutely, but distantly denticulate; here the serrations are much closer, gradually increasing in size and acuteness almost from the leaf-base. The seta is stouter, and shorter than it often, at least, is in *A. cucul-*

ligerum, though it may there also be only 1 cm. long. The principal difference, however, lies in the perichaetial leaves; in *A. cuculligerum* they are slightly denticulate only; here the whole acumen is densely fringed with long, almost ciliolate teeth. The seta, as in *A. cuculligerum*, is set, in the upper part with flat, sub-discoid thickenings, such as are found here and there in various genera, e. g., in several species of Meiothecium; it would seem desirable to have a suitable term for these; and I suggest tentatively the terms platypapillae, platypapillose.

Acroporium leucophyllum Dixon sp. nov. (PLATE 4, FIG. 6)

Sat robustum, *peralbidum;* caulis longe repens, irregulariter pinnatus, ramis nunc brevioribus, subobtusis, plerumque *elongatis, rigidiusculis, valde attenuatis, ad 3 cm. longis, caudiformibus.* Caulium et rami cortex *nigricans*, inter folia albida valde conspicuus.

Folia saepe spiraliter seriatim disposita, erecta, erecto-patentia vel saepe rigide divergentia, lanceolata, *ab insertione fere* paullo angustiore *sensim angustata*, valde concava et *profunde carinata*, longiuscule *stricte* anguste acuminata, marginibus infra subrecurvis, *ad basin acuminis explanatis, acumine ipso argute denticulato fortiter late recurvis*, unde acumen *dorsaliter subconvolutum.* Folia apicem versus ramorum sensim magis magisque minora, angustiora.

Cellulae peranguste lineares, parietibus tenuibus, dorso apicibus valde prominentibus *hispide papillosae*, infra vix mutatae sed laeves, inferne aurantiacae, alares circa trinae vesiculosae, *intense purpureae, opacae.* Cetera ignota.

HAB. On wood, Gunong Tahan, Pahang, July 1911; Ridley (1032).

A very distinct and striking species, both in habit and the white colour, and in the structure of the leaves. *A. asperifolium* (Thw. & Mitt.) is perhaps the nearest, but is greener in colour, and the leaves, much less papillose at back, are very longly and gradually tapering and of quite different form. *A. ruficaule* is quite different in size, habit and colour.

The form of the acumen is rather remarkable; as in many species with concave leaves (Trichosteleum, Chaetomitrium, &c.) the base of the acumen is flattened out at the margins, with the centre hollowed out and subcucullate; but higher up in

the acumen the margins become widely revolute, so as almost or quite to meet *at the back*, rendering the *back* of the acumen subtubular, a very unusual feature.

The long, attenuated branches would appear to be pendulous.

The rather small, deep purple auricles contrast very strongly and prettily with the narrow, pale, lamina cells.

The spiral arrangement of the leaves comes out rather strikingly when dry, in more than one way. On some branches the leaves are rigidly divergent and little altered when dry, in which case they give the appearance of a spiral herring-bone arrangement. At other times the leaves of each spiral become accumbent on one another, and the resulting strand is twisted spirally round the branch, in a funicular manner, not, however, crowded as in *Grimmia funalis* and many species of Macromitrium, but distantly, so that the black cortex of the branch shows distinctly and prettily in contrast with the white leaves. (I have tried to depict one of these branches on Pl. II. fig. 6b). Frequently, on the other hand, the spiral arrangement is not at all manifest.

Acroporium obscurum (Broth.) Dixon sp. nov. (*Sematophyllum obscurum* Broth. MS. in sched.) (PLATE 4, FIG. 7)

Dioicum. Sordide viride. Habitus et folia fere *A. rufi* formarum robustiorum, ramis saepe elongatis, flexuosis. Folia rigide patentia, saepe homomalla, superiora plerumque *leniter falcato-secunda*, lanceolato-subulata, e basi fere convoluta, apice tubulosa, stricta *acuta sed haud valde attenuata*, integra, superne dorso plerumque (praecipue superiora) *rugosa-papillosa*. Cellulae parietibus *valde incrassatis*, porosis, obscurae.

Flores ♂ numerosi, majusculi, caulini. Perichaetium majusculum, bracteis *angustis*, internis erectis, *sensim in subulam piliformem, flexuosam, quam laminam saepe multo longiorem, grosse dentatam*, attenuatis, 3 mm. fere longis. Seta *usque ad 3 cm. alta, laevis*. Theca immatura solum visa.

HAB. Lohore, Aug. 1908; Ridley (sine numero); det. Brotherus. Penang Hill, Pulau Penang, 1896; Ridley (538) in herb. Mitten; det. H. N. D. Oto Jungle, Upper Sarawak, Borneo; Ridley (sine numero) in herb. Mitten; det. H. N. D.

The foliation is very much that of robust *A. rujum* or the smallest forms of *A. secundum*, but the fruiting characters are quite different; the long, quite smooth seta separates it from

the former, and the long perichaetial leaves with long, flexuose, strongly toothed piliform points often as long as or considerably longer than the expanded part, from all forms of *A. secundum*. The perichaetial bracts vary a good deal, however, and are sometimes much less longly piliform, and less coarsely toothed; but are still quite different from those of *A. secundum*. The perichaetium figured is one of the more shortly pointed forms.

The subula of the leaf, as in many of the allied species varies much in degree and character of papillosity; it may be quite smooth or lowly undulate-rugulose, or highly and acutely papillose. The cells are rendered rather obscure by the cell contents.

Acroporium rigens (Broth.)

dicranolomoides (Broth.) Dixon. var. nov. (PLATE 4, FIG. 10)

Sematophyllum dicranolomoides Broth. n. sp. in sched.

Folia laxiora quam in planta typica, valde patentia, minus stricta. Habitu formarum minorum specierum nonnullarum Dicranolomatis, e. g., *D. brevisetum*, *D. reflexifolium*. Sporogonium ei plantae typicae simile.

HAB. Gunong Berumban, Pahang, 1908; Ridley (131).

The more loosely set leaves, divaricate, sometimes at right angles to the stem, give this a quite different appearance to that of the densely and rigidly foliate type form, but there are no other differences in either the leaves or the fruit.

Eucamptodon Wrayi Broth. in sched. in Herb. Kew., "summit of Gunong Batu Putih, Perak, L. Wray Jr., No. 394. Herb. Mus. Perak," is the same thing. The resemblance to some of the Dicranaceous genera, e. g., Braunfelsia (Eucamptodon auct.) is quite striking, particularly of course in sterile specimens.

Acroporium denticulatum Dixon sp. nov. (PLATE 4, FIG. 8)

Dioicum videtur. Inter alios muscos intertextum, *nitidissimum*, *albidum*, *A. hamulato* Fleisch. forsan affine sed *minus*, *brevius*, atque colore omnino alienum. Folia circa 1.5 mm. longa, eis *A. monoico*, &c., simillima, sed apice *paullo angustiore*, *saepe obliquo vel leniter falcato; marginibus per totum ambitum fere minute, distanter denticulatis*. Folia ramea angustiora, longius cuspidata. Cellulae parietibus *incrassatis* valde porosis,

circa dimidiam latitudinem luminis aequantibus; superne dorso saepius *rugulosae*, vel humiliter papillosae.

Cetera nulla.

HAB. Fraser Hill, Pahang, alt. 4000–4370 ft., 1922; Burkill & Holttum (8715a).

Growing densely interwoven with close masses of *A. secundum* var. *angustifolium* Fleisch., *Trichosteleum hamatum* and *T. Boschii*, so that it is very difficult to separate it or to judge of the actual habit of growth. It is however very distinct from all the allied species in the glistening white colour, and the denticulate margins. The toothing being very delicate and the margins usually strongly incurved, this may easily be overlooked, but on careful examination it will be seen to be almost constantly present, and frequently at the leaf apex very pronounced. The rugosity of the leaves also is unusual in the wider leaved species.

The cuspidate leaf-points are usually straight, but quite frequently hooked slightly, as in *A. hamulatum*.

Acroporium aciphyllum Dixon sp. nov. (PLATE 4, FIG. 9).

E majoribus generis, habitu *A. falcifolii* Fleisch. sed *multo robustius*, caespites altos, extensos, laxiusculos formans; caules 8 cm. longi vel supra, parce ramosi, apice *brevicuspidati, falcati*. Folia magna, 3–4 mm. longa, valde *falcato-secundo; e basi late ovato-oblonga parum concava sat cito in subulam subaequilongam inferne convolutam superne piliformem substrictam* contracta; integerrima, dorso laevia. Cellulae *perincrassatae*, parietibus porosis quam lumine multo latioribus, unde pori *valde conspicui, elongati*, parent; alares magnae, vesiculosae, sat *angustae, elongatae*.

Dioicum videtur. Flores feminei solum visi, apices versus ramorum siti; perichaetii bracteae *erectae, arcte adpressae*, e basi *late convoluta* superne denticulata in subulam *piliformem rectam argute denticulatam* contractae. Seta circa 2 cm. alta, inferne laevis, apice leniter rugulosa. Theca pendula, angusta.

HAB. Gunong Tahan, Pahang, 1911; Ridley (1017, 1029). Ibidem (1037), f. foliis patentibus, haud falcatis.

This fine species differs from all the known Malaysian species with broad leaf bases at once in the long, fine, often piliform subula. *A. sigmatodontium* is perhaps the nearest species, but has leaves much narrower below, less finely acuminate, with very different perichaetial leaves.

No. 1037 has the leaves quite straight, and may possibly be the type form, but only a stem or two were seen of this, while the falcate-leaved plant is present in considerable quantity, and must be presumed to be the prevailing form.

A. piliferum Broth. from the Philippines has much wider leaves, more rapidly, often quite abruptly piliferous.

Acroporium longicuspis (Broth.) Dixon sp. nov. (PLATE 4, FIG. 12)

Sematophyllum longicuspis Broth. MS. in sched.

Habitu staturaque *S. secundi* var. *angustifolii* Fleisch., sed folia parum secunda, undique patentia. Folia *breviuscula*, circa 2 mm. longa, e basi subconvoluta *ovato-lanceolata*, *stricte subulato-tubulosa*, integerrima; cellulae majusculae, *valde incrassatae*, lumine parietem porosam latitudine subaequante, dorso plerumque mamillose *undulato-rugosae*, saepius quoque *papilla unica media alta grosse scabrae*.

Dioicum videtur. Perichaetium sat parvum, bracteis erectis e basi late ovata in acumen subpiliforme vel loriforme *subaequilongum argute denticulatum* angustatis. Seta 1.5 cm., laevis vel apice paullo rugulosa. Theca parva, *pendula*.

HAB. Taiping, Perak, 1909; Ridley (200). Fraser Hill, Pahang, 4000–4370 ft., 1922; Burkill & Holttum (8711). Bukit Hitam, Selangor, 1896; Ridley (391).

Somewhat resembling the narrow-leaved forms of *A. secundum* this species differs in the short leaves not twisted and rarely secund; in the more incrassate cells, and especially in their papillosity. They are frequently markedly rugulose at back above, as in several species, but in addition to this in most leaves all the upper cells bear a high single median papilla so that the leaf is strongly scabrous. Curiously, however, among the normally papillose leaves there are frequently found branches with slightly longer and narrower leaves which are entirely or almost entirely smooth; a very marked example of dimorphism. A certain degree of rugulosity is frequent in the narrow-leaved species of Acroporium, and a few species have occasionally at least a distinct central papilla on the cell lumen—though this is rare—but I know of no species where it is so marked and so highly developed as here; in fact the leaf may be said to have

the form of Acroporium with the papillae of Trichosteleum, e. g., *T. Boschii*.

The seta also is shorter than in *A. secundum*, and the perichaetial leaves, though similar, are not identical, having a straighter and longer, more gradually tapering subula.

The leaves in this genus, at least in the Section Eu-acroporium, fall into two groups as regards outline. In most of the larger species the general outline is oval, with a more or less cuspidate, semi-convolute tip, which however bears a very small proportion in length to that of the whole leaf. In the other group, mostly of the smaller species, but including *A. secundum* of the larger ones, the outline of the leaf is narrow throughout, and the leaves frequently taper almost from the base, often being more or less convolute throughout, or at any rate tubular and subulate for a great proportion of their length. The present plant, with *A. falcifolium* Fleisch. and *A. aciphyllum* described above, holds a somewhat intermediate position, the two latter, however, belonging rather to the first group, while the present plant is clearly of the second.

The Pahang and Selangor plants were named and distributed as *Sematophyllum perpapillosum* Dixon sp. nov. before I saw Brotherus' species.

Acroporium albidissimum Dixon sp. nov. (PLATE 4, FIG. 13)

A. longicuspidi Broth. ante descripto affine; differt colore *pulchre albido, nitido*, foliis *multo brevioribus*, latioribus, oblongis, breviter, stricte, *subobtuse, tubuloso-acuminatis; areolatio et papillae similes;* rami quoque nonnulli dimorphi foliis multo angustioribus, subcylindricis, laevibus vel sublaevibus inveniuntur.

Planta sterilis solum nota.

HAB. Among *Rhizogonium spiniforme*, Gunong Tahan, Pahang, 1911; Ridley (1023b).

The highly papillose cells are identical in this and the last species, and apart from any possible fruiting characters the difference lies entirely in the white colour, and the much broader and shortly pointed leaves. The dimorphism of the branches is quite as clearly marked here.

Acroporium Ridleyi Dixon sp. nov. (PLATE 4, FIG. 14)

Sat robustum, *albescens*, *nitidum;* caules *elongati*, ad 6 cm. longi, *complanati*, ad 4 mm. lati; *parce ramosi*. Folia plusminusve complanata, valde divergentia, saepe horizontaliter explanata, 2 mm. longa vel paullo ultra, *obovato-oblonga*, perconcava, *apice acuto*, *subconvoluta*, integerrima; areolatio *specierum duarum praecedentium*, cellulis alaribus *permagnis*, pulcherrime aurantiacis.

Cetera nulla.

HAB. Gunong Tahan, Pahang, 1911; Ridley (1039).

A very distinct species in the colour, habit, papillose cells and leaf form.

These three species, *A. longicuspis*, *A. albidissimum*, and *A. Ridleyi*, form a new and very distinct group of Acroporium, having the general leaf form of Eu-acroporium, but in the highly papillose cells coming near to Trichosteleum. The alar cells, however, are quite distinctive of Acroporium. The cell structure is identical in all three (except that in the present species I have found no dimorphic branches), and is very marked, not only in the dorsal papillae and rugulosity, but also in the uniform, highly incrassate cells. The colour of the present plant is whitish, but scarcely so marked as in the last; the leaves are quite different in form from both species, and are almost identical in outline with those of *A. mcnoicum* and *A. hermaphroditum*.

Acroporium complanatum Dixon sp. nov. (PLATE 4, FIG. 15)

Hypno pycnophyllo C. M. (Sematophyllum Jaeg.) affine; differt ramis *complanatis*, foliis bifarie divaricatis, subula *multo latiore*, breviore, robustiore *late loriformi*, *obtusiuscula*, *rigida*, superne *dense*, *argute* serrulata. Cellulae laeves vel humiliter papillosae. Perichaetium parvum, ut in *A. pycnophyllum*, sed foliorum subula, tanquam foliis caulinis, *latiore*, *breviore*, *loriformi*. Seta .75–1 cm. longa, infra laevis, apice grosse nec alte papillosa, theca parva, horizontalis, castanea. Peristomium saturate rubrum, dentes lati, approximati, dorso fortiter dense transverse striolati, linea media irregulari, *haud sulcati*.

HAB. Base of Gunong Ledang, Malacca, 1892; Ridley (236).

Clearly allied to *Hypnum pycnophyllum* C. M., but differs at once in the leaves widely spreading almost at right angles to the branch, in one plane, so that the branches are flattened (the

leaves themselves, however, not lying in that plane); and in the coarse, rigid, wide subula, instead of the long, piliform flexuose one of *H. pycnophyllum*.

That species has usually been placed in Sematophyllum (Acroporium), but is transferred to Warburgiella by Fleischer, with one or two species of somewhat near alliance. This has necessitated the widening of the generic character, especially in regard to the calyptra, which as the genus is defined by C. Mueller is campanulate or mitriform, not cucullate. The genus as enlarged appears to me rather ill-defined, and I should be inclined to keep it restricted as by C. Mueller.

Hypnum pycnophyllum is placed by Brotherus with about a dozen species more or less allied, under the Section Chaetomitriella (C. M.). Some of these certainly, as *S. palanense* (Hampe) and *S. bistrumosum* (C. M.), and others less clearly, appear to me better placed in Trichosteleum than in Acroporium. The small group to which *H. pycnophyllum*, the present and following two species belong, is however perhaps best kept in Acroporium.

Acroporium malayanum Dixon sp. nov. (PLATE 4, FIG. 16)

A. pycnophyllo (C. M.) and *A. cuspidatifolio* (Fleisch.) affine; ab illo cellulis *multo latioribus*, 6–8 μ latis, *opacioribus*, *incrassatis*, dorso superne *plus minus spiculosis*, foliis *angustioribus*, *minus cito*, *brevius*, *minus flexuose*, subulatis, ramisque *obtusis* differt; ab hoc ramis plus minus complanatis, cellulis *opacioribus*, marginalibus *haud diversis*, apice *prominente*, spiculoso, *sine papillis medianis*.

Dioicum. Planta mascula solum visa.

HAB. Botanical Gardens, Penang, 1915; Binstead (57).

Very near to *A. pycnophyllum*, but that species has more concave, wider leaves, less spreading, more abruptly contracted into a long, flexuose piliform arista, the cells there are much narrower, thin-walled, pellucid, and smooth at back. The cells here are decidedly incrassate, much wider, and opaque with the cell contents.

Warburgiella cuspidatifolia Fleisch., of which I have seen no specimen, has leaves, from the description, of a similar form, but the marginal cells are there shorter and differentiated from the inner, and the upper cells have a strong papilla in the middle of the lumen; in the present species it is the apices of the cells alone that are prominent and spiculose.

Acroporium surculare Dixon sp. nov. (PLATE 2, FIG. 11)

Caulis *longe prostratus*, sat robustus, irregulariter, subpinnatim ramosus, ramis erectis, vel patentibus, saepe subfasciculatis, complanatis, subnitidis, sordide viridibus, 2–3 mm. latis, foliorum axillis *surculos microphyllos capillares numerosos 1–3 cm. longos* emittentibus. Folia 2 mm. longa, *perconcava*, e basi contracta late oblongo-ovata, marginibus incurvatis, apice *subcucullata, raptim in acumen breviusculum latiusculum acutum denticulatum* contracta. Cellulae angustissime lineares, *laeves*, parietibus sat tenuibus, indistinctis, inferiores paullo laxiores, infimae *aurantiacae*, alares plures vesiculosae magnae.

Cetera nulla.

HAB. On twigs, Bidor Road, Tapah, Perak, 1908; Ridley (153). Penang Hill, Pulau Penang, 1896; Ridley (551).

Somewhat intermediate between *A. complanatum* (described above) and *A. pycnophyllum* (C. M.). Larger than the latter species, with complanate branches, and with the acumen of the leaf much shorter and not piliferous, but much narrower and shorter than in the former, the cells also in the present species are, so far as I have examined them, quite smooth. The flagelliform ramuli are quite different from anything I have seen in the genus.

Explanation of plate 3

The type specimen is figured in each case.
The figures indicate the magnification.

FIG. 1. *Braunfelsia longipes*—*a*, leaf, 5. *b*, alar cells, 40.
FIG. 2. *Dicranoloma brevicapsulare*—*a*, capsule, 3.
FIG. 3. *Thysanomitrium abbreviatum*—*a*, leaf, 5. *b*, section of nerve (*a* . . .*b*, width of nerve; c, central strand of nerve.), 40.
FIG. 4. *Thysanomitrium Ridleyi*—*a*, leaf apex, 20.
FIG. 5. *Fissidens subdiscolor*—*a*, stem, 1. *b*, leaf, 20. *c*, leaf apex, 40.
FIG. 6. *Fissidens amblyotis*—*a*, stem, 1. *b*, leaf, 20. *c*, cells, 200.
FIG. 7. *a*, *Syrrhopodon bornensis*, upper part of stem, dry, 4.
b, *S. Ridleyi*, upper part of stem, dry, 4.
c, *S. rufescens*, upper part of stem, dry, 4.
FIG. 8. *Syrrhopodon elimbatus*—*a*, leaf, 10. *b*, apex of leaf, 50.
FIG. 9. *Syrrhopodon perakensis*—*a*, leaf apex, 50. *b*, leaf base, 20. *c*, marginal cells of mid-leaf, 200.
FIG. 10. *Calymperes constrictum*—*a*, leaf apex, 50. *b*, margin at shoulder, 40. *c*, margin of mid-leaf, 200.
FIG. 11. *Pinnatella lingulata*—*a*, leaf, 20. *b*, apex of leaf, 40.
FIG. 12. *Chaetomitrium perakense*—*a*, apex of perichaetial leaves, 40.
FIG. 13. *Chaetomitrium setosum*—*a*, leaf, 20.

FIG. 14. *Clastobryum prionotrichum*—*a*, plant, 1. *b*, leaves, 25. *c*, alar cells, 50.

FIG. 15. *Ectropothecium callichroides* var. *elongatum*—*a*, stem, 1.

FIG. 16. *Ectropothecium siamense*—*a*, stem and branch leaves, 20. *b*, leaf apex, 50. *c*, upper marginal cells, 200.

FIG. 17. *Taxithelium trachaelophyllum*—*a*, leaf, 20. *b*, marginal cells, 200. *c*, alar cells, 40.

FIG. 18. *Taxithelium subtrachaelophyllum*—*a*, leaf, 20. *b*, marginal cells, 200. *c*, alar cells, 40. *d*, upper part of perichaetium, 20.

Explanation of plate 4

FIG 1. *Taxithelium isocladioides*—*a*, leaf, 20. *b*, upper margin, 100.

FIG. 2. *Taxithelium bilobatum*—*a*, dorsal leaf, 20. *b*, lateral leaves, 20. *b*, lateral leaves, flattened out, 20.

FIG. 3. *Acanthocladium polymorphum*—*a*, leaf, 20. *b*, *b'*, *b''*, apices of branch leaves, 40. *c*, upper cells of *b''*, 200. *d*, upper cells of *b'*, 200.

FIG. 4. *Trichosteleum albifolium*—*a*, stem leaf, 20. *b*, branch leaf, 20. *c*, alar cells, 100. *d*, upper cells, 200.

FIG. 5. *Acroporium serrulatum*—*a*, *a'*, leaves, 20. *b*, apices of perichaetial leaves, 50.

FIG. 6. *A. leucophyllum*—*a*, plant, 1. *b*, branch, 2. *c*, leaf, 20. *d*, apex of branch leaf, 50. *e*, upper cells, 200.

FIG. 7. *A. obscurum*—*a*, upper part of perichaetium, 20.

FIG. 8. *A. denticulatum*—*a*, leaf, 20. *b*, upper margin, 50.

FIG. 9. *A. aciphyllum*—*a*, leaf, 10. *b*, perichaetium, 10.

FIG. 10. *A. rigens* var. *dicranolomoides*—*a*, stem, 1.

FIG. 11. *A. surculare*—*a*, plant, 1. *b*, leaf, 10.

FIG. 12. *A. longicuspis*—*a*, leaf, 10. *b*, dorsal cells in profile, 50.

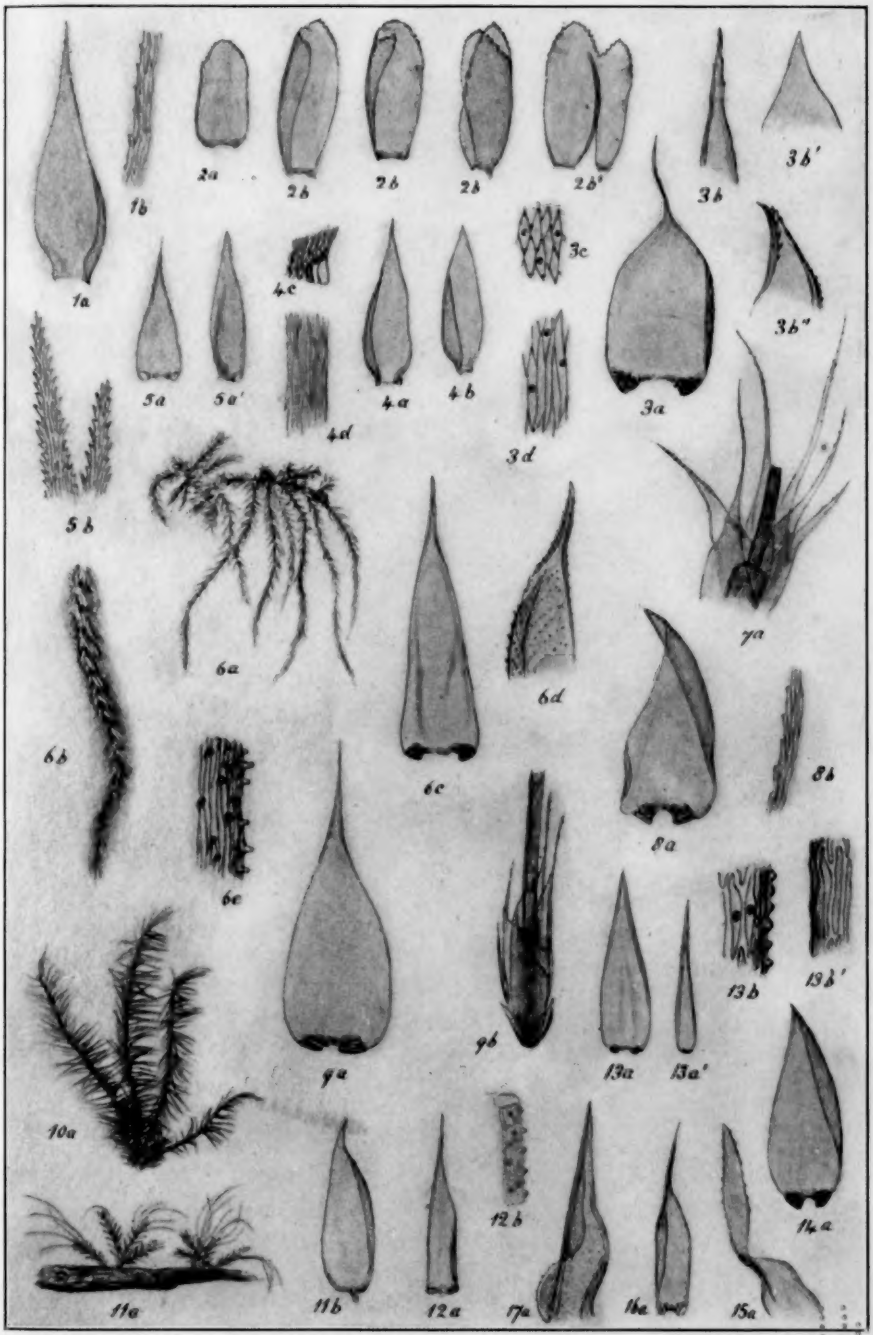
FIG. 13. *A. albidissimum*—*a*, *a'*, leaves, 10. *b*, upper cells of *a*, 200 *b'*, upper cells of *a'*, 200.

FIG. 14. *A. Ridleyi*—*a*, leaf, 10.

FIG. 15. *A. complanatum*—*a*, leaf apex, 40.

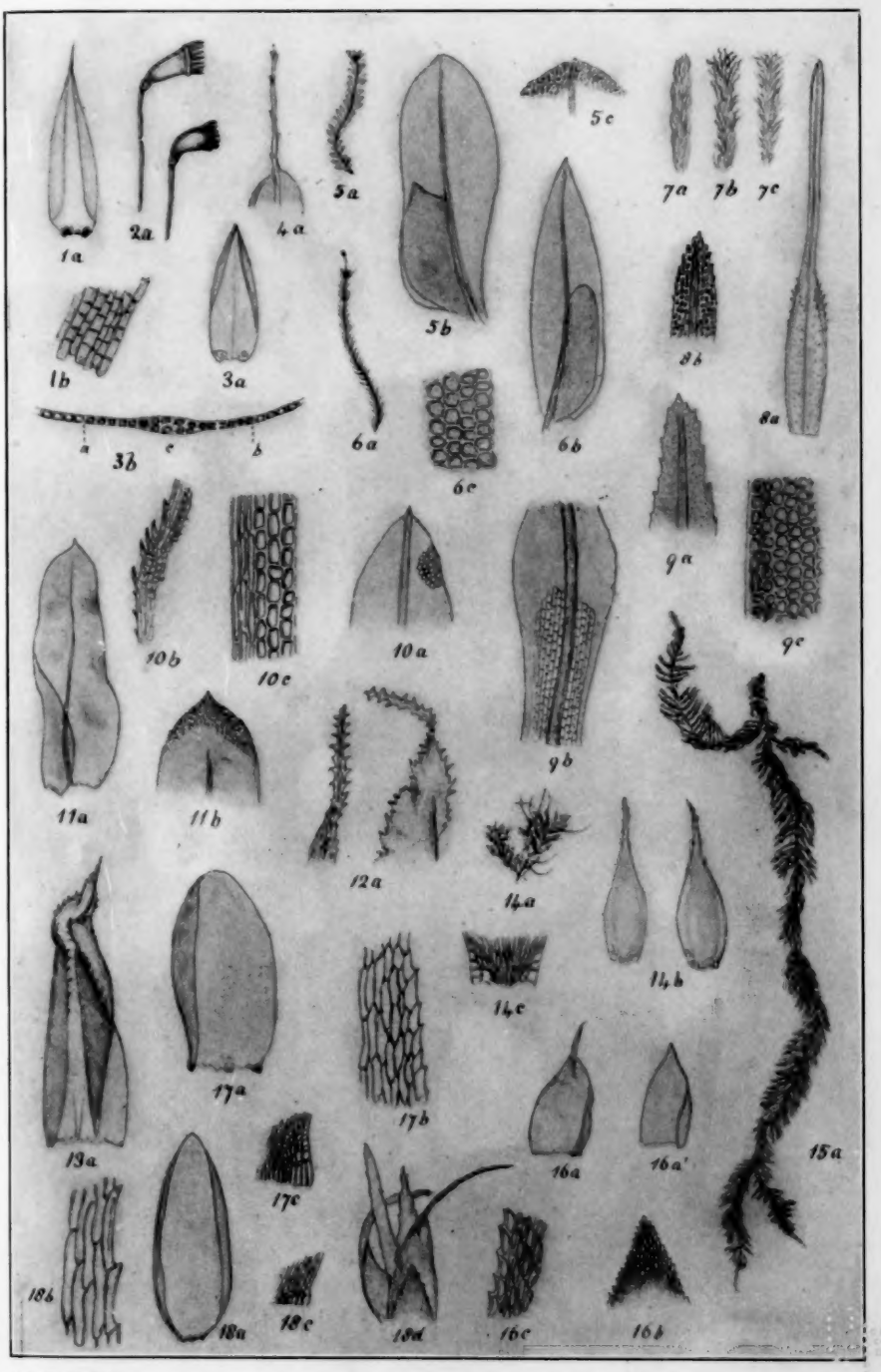
FIG. 16. *A. malayanum*—*a*, leaf, 10.

FIG. 17. *Syrrhopodon pungens*—*a*, leaf apex 40.



del. H. N. Dixon

DIXON: MALAY MOSSES



del. H. N. Dixon

DIXON: MALAY MOSSES

Cytological Study of Living Cells of Tobacco Plants Affected with Mosaic Disease

BESSIE GOLDSTEIN

As one phase of a more extensive cytological study of the diseased cells in tobacco mosaic, as well as the mosaic of Solanum sculeatissimum and other plants, I have recently spent some time in the study of the now well-known intracellular mosaic bodies in the living condition. In epidermal and hair cells mounted in water, the bodies are easily recognizable and can be studied for hours at a time under the immersion lens.

The facts as to their structure, varying sizes and shapes, and their relation to the other contents of the cell are so definite and easily demonstrable, that I am presenting a number of figures illustrating their appearance in the living cell in advance of a more extended account of their appearance and behavior as shown in fixed and sectioned material.

The epidermis of the diseased tobacco leaf is stripped off by the ordinary methods, and mounted in water. Material from the midrib and petiole is especially favorable, and such preparations mounted under zero cover slips, can be easily studied with the 1/12″ oil immersion lenses. The intracellular bodies are found in both epidermal and hair cells. I shall call them X bodies.

In such preparations, these X bodies appear at any particular moment as oval or perfectly rounded or more or less amoeboid in outline, as in figures 1, 2, and 5. They may lie in close contact with the nucleus, often as it were apparently wrapped around it, or they may be found in any other region of the cell.

Internally they may be very coarsely and unevenly granular, or they may appear very evenly and finely granular as in figure 2. They may contain several large vacuoles, or many small ones, as in figure 1. Sometimes the material of the body appears quite regularly alveolar as in figure 2.

In figure 1 is shown an epidermal cell from the midrib in which the nucleus contains three nucleoli. Scattered through the cytoplasm are small chloroplasts. The X body lies in con-

tact with the nucleus. It is densely granular and contains several small vacuoles. Careful and prolonged observation of such bodies shows that they undergo slow changes in position and sometimes of form. The contents seem sometimes to become more vacuolar. This body closely resembles the bodies found in sectioned and stained material, as in figures 7 and 8, in its irregularly lobed or oval outline, in its compact granular structure, and in the presence of one or more vacuoles. Bodies of this kind can be seen in almost every cell of a bit of epidermal tissue stripped from the yellow area of the midrib or leaf blade.

Such bodies as this shown in figure 1 are not the result of nuclear fragmentation or direct nuclear division as Iwanowski first suggests. From his figures and mine, it is clearly evident that the finely granular and rounded nucleus could not be fragmenting or giving rise by direct division to daughter nuclei.

They do not represent migrated nuclei such as Miehe observed in stripped off epidermal tissue of Tradescantia stems and leaves of Allium. Miehe found the nuclei that had migrated through the cell walls into adjacent cells showed exactly the same finely granular content as did the original nucleus of the cell.

I have also attempted to stain preparations containing such cells as shown in figure 1, with various intra-vitam nuclear stains. I have obtained the best results with thionin. In a drop of water placed against the edge of the cover glass, a grain of the stain was dropped. This gradually dissolved and the violet color slowly diffused under the cover glass. The nucleus of the cell takes a lavender tint, while the nucleole stains violet. The X body does not take the stain as a whole but its granules seem to become more clearly differentiated.

In figure 2, the nucleus is shown, as is frequently the case, suspended in the cell by fine cytoplasmic threads in which active streaming is going on. In this cell five X bodies are lying about the nucleus. Within the bodies themselves, active motion of granules, amounting almost to circulation, was conspicuous. All five of these bodies were slowly rotating and at the same time gradually changing their positions in the cell. During the several hours in which this cell was under observation, the bodies moved up and down the cell for considerable distances, continually changing their positions relative to the nucleus and to each other.

Often as the bodies slowly rotate they seem to roll along the protoplasmic threads of the host cell. This movement seems quite independent of the rate of streaming of the cytoplasm of the host cell. The bodies do not all move along at the same rate. In fact they often pass one another. One may turn back or move across the cell, while the others continue their way lengthwise of the cell.

The general interrelations of the X bodies and the other constituents of the cell can be even better seen perhaps under lower magnifications. In the cell shown in figure 3, drawn under a magnification of 450 diameters, eight X bodies were found. Here also the nucleus is seen imbedded in a mass of cytoplasm from which streaming threads arise. Along the threads are very many small pale green chloroplasts. In this cell as noted are three large X bodies and five very small ones. They all have a finely granular structure with coarser granules which showed what was probably Brownian movement. These X bodies were constantly changing their positions in the cell. The streaming cytoplasmic threads were also constantly taking new positions, lying now across the cell, now diagonally longitudinally through the cell, or merging in the cytoplasm of the primordial utricle.

In figure 4, I have shown a normal hair cell from a healthy leaf for comparison with these cells containing the X bodies. It is obvious at once that there are no conspicuous differences in the distribution of the cytoplasm and its relations to the nucleus between such a cell and the cells with the X bodies. The position of the nucleus, the streaming and constantly changing cytoplasmic threads, and the distribution of the very small pale green plastids, resemble in general the same structures and conditions found in the cell shown in figure 3.

As noted the nucleus may lie suspended in the cell by cytoplasmic threads or be pressed close to the wall of the cell. Usually the nucleus lies in the primordial utricle against the wall of the cell. I have seen the nucleus, in a hair cell containing the rotating X bodies, move out from the wall with the radiating streaming cytoplasmic threads about it, and hang suspended in the cell vacuole without further changing its position during a period of observation lasting five hours. The nuclei of the cells in figures 3 and 4 were being carried by the streaming cytoplasm

around the periphery of the cell during the whole period of several hours during which the drawings were made.

Kunkel seems to emphasize somewhat the fact that the X bodies lie in intimate association with the nucleus of the cell. My observations do not lead me to attach any very special significance to such a position, especially in the case of the hair cells. From my studies of living material, and also from the appearance of the nucleus in fixed preparations of both diseased tissue in which the bodies are present, and healthy tissue, I find no evidence that the nuclei in cells from mosaic diseased areas are at all changed in appearance by the presence of the X bodies. The bodies, as they move through the more fluid cytoplasm or cell sap, may come to rest upon the nucleus. It appears simply as an impediment to their movement. In one instance, a cell was observed in which there were several very large rounded X bodies lying about the nucleus which was thus quite obscured from view though it could be seen by carefully focusing down among the bodies. After some time, the bodies gradually moved away, so that the nucleus now came into clear view. It was then seen to be very much flattened on one side apparently where the bodies or a body had been closely pressed against it. After several minutes, the nucleus slowly rounded out and regained its normal oval outline. It showed no further changes although the cell was studied several hours.

I find no evidence from my studies that the X bodies could be considered as secretion or disorganization products arising from or in the neighborhood of the nucleus. I have studied very many preparations from healthy leaves but they have never been found to contain these bodies.

Kühne has described a balling up of the protoplasm of living stamen hairs of Tradescantia under the influence of electrical stimulation. In such electrically stimulated cells, when the charge was strong, the entire primordial utricle became loosened from the walls and hung suspended in the cell space by a few threads still attached to the walls. A weaker charge led to the breaking up of the strands of protoplasm. The fragments then rounded up into globules or rounded masses. In such preparations the balls of cytoplasm within a few hours elongated and flowed back again into the streaming cytoplasm.

The X bodies in my preparations keep their form in living

preparations of tissue kept in a moist chamber for several days. Their content, however, becomes very granular, and no movements of the body or its contents were observable after the second day.

The X bodies as I have noted often exhibit distinct but sluggish amoeboid movements. They also are bounded by a definite plasma membrane as is clearly shown when the more active X bodies thrust out short rounded pseudopods. The presence of this membrane can also be demonstrated when acids or drops of fixing solutions are added to the water under the cover slip. The content of the body then contracts thus showing that it is separated from the cell sap by a definite limiting layer. The contents of the contracted X body also appears more coarsely granular and distinctly vacuolated.

In figure 5, the nucleus lies suspended in the cell vacuole. The body here is granular in structure, and showed conspicuously a sort of vibratory motion, and perhaps a circulation of its granular content. This body continually changed its form by putting out slight bulbous projections on all its surfaces which were withdrawn again after several seconds, while other projections arose in other parts. It continually showed changes of position, moving up over the nucleus, or across the striated body, and then back again to the position shown in the drawing. These motions were not easily to be associated with the streaming movements of the cytoplasm. The X body did not as long as the cell was observed, during a period of several hours, move away from the vicinity of the nucleus and the striated body.

Such amoeboid X bodies have also been observed to move through the cell. The amoeboid processes are put out in the direction of the movement, and these often show a clear hyaline area at their blunt extremities. I am not certain, however, that the entire movement of the X body is due to the thrusting out of these projections though the entire body appears to move forward at the same time that the projection is put out. When the body turns after moving forward in a certain direction, it elongates, or becomes less rounded, or oval, and this elongation is in the direction of the turning movement. The body may now appear pear shaped. The upper narrower region now swings around toward the direction in which the body will soon begin to move.

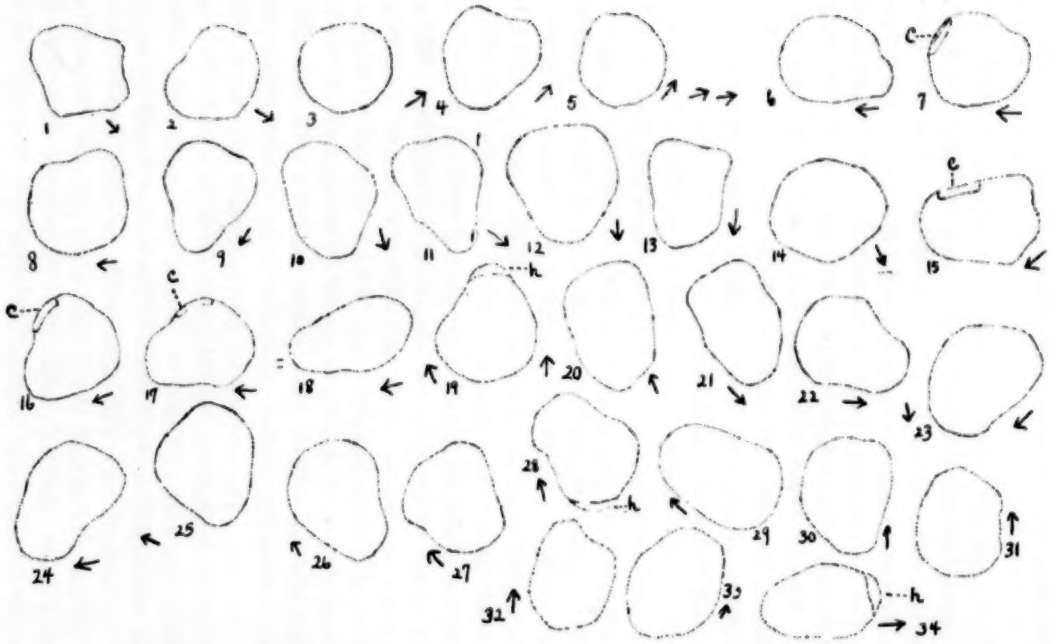


FIG. 1. Camera sketches of the changes in form of an X body as it moved through a diseased hair cell of the tobacco. Period of observation one and one-half hours. There was only one X body in the cell and in appearance it resembled the one shown in plate 1, figure 5. Magnification about 1,200.

I have diagrammed with the aid of a camera lucida the changes of form which one of these X bodies showed in the course of one and one-half hours. The stages are numbered from 1 to 34 and are shown in text figure 1. In several stages a clear hya-

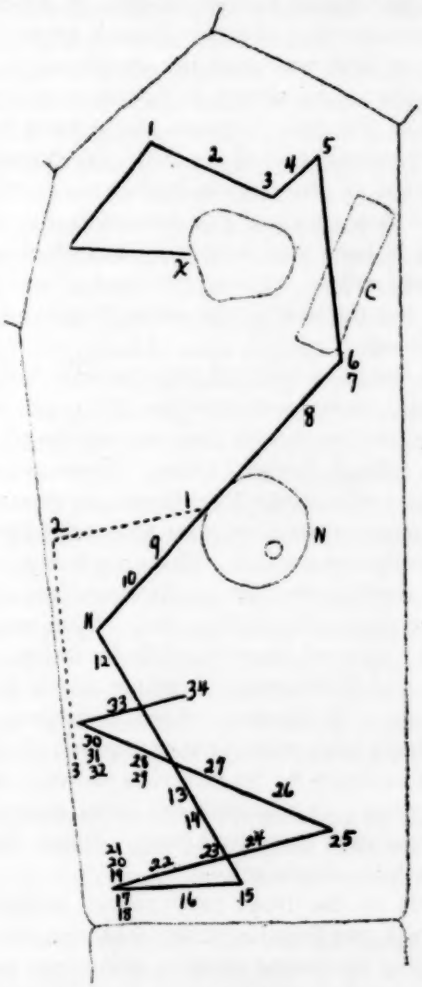


FIG. 2. Diagram of a cell from a branching trichome showing the general direction of the path followed by the X body whose changes in form are shown in text figure 1. The movement of the nucleus for the same period is also shown in the dotted line.

line ectoplasm-like cap (h) was seen on a more or less protruding portion of the X body. A small crystal (c) either adhering to its surface or embedded in the X body was also seen at several stages. The whole series of figures while not suggestive of the active pseudopod formation seen in Amoeba proteus is certainly not unlike that of more sluggish types.

The body at first was near the distal end of the trichome cell. During the stages shown in figures 1–15 it moved to the proximal end of the cell. Figures 16–34 show its later movements in the proximal end of the cell. Its general path during the whole period of observation is diagrammatically shown in text figure 2. How much of this motion is due to autonomous activity of the X body, and how much to cytoplasmic streaming in the trichome cell is not easy to determine. Certainly the movement of the nucleus in the same direction is due to cytoplasmic streaming.

Cells from the paler areas of the mosaiced leaf also show the presence of great numbers of crystals. Although similar crystals are present in healthy tissue, they are not nearly as abundant as they are in cells of diseased tissue. These crystals appear as hexagonal plates of various thicknesses, as irregular polygonal plates, or as more or less irregular elongated forms with cross striations as in figures 5 and 6. These various appearances may be due to the varying positions of the crystals in the cells as well as to the occurrence of twinning, etc. I am reserving a fuller report on the nature of these crystals for a later paper.

Figures 7 and 8 represent drawings made from fixed and stained material. In figure 7 there is present an elongated cross striated body lying within the protoplast. A similar striated body is shown in figure 8. Such bodies are very common in my sectioned material. In the diseased areas nearly every cell is found to contain such a striated body. Often there are two or three of them in a single cell.

If one adds to the fresh preparations mounted in water, Flemming's weak, medium, or strong solutions, or chromo-acetic solution, allowing the preparations to stand over night in a moist chamber, the typical crystal forms are no longer found. Instead one finds long irregularly lobed and striated masses which are stained deep yellow by the fixative. That at least many of the crystals actually become the striated bodies found in fixed

material can be easily demonstrated by a few hours observation under the microscope of living preparations to which drops of the fixing solutions are added from time to time. Only the smallest thin crystalline plates will disappear entirely.

Iwanowski has figured several somewhat amoeboid bodies, "amöben erinnernde Plasmaanhäufungen," attached to nuclei, as seen in sections of living material of mosaic infected tobacco leaves. He also observed the presence of the numerous crystalline plates in the living cells, which in fixed material, according to his description, seemed to have disappeared entirely and given place to plates in which were imbedded small rod-like bodies. He concludes that these are plates of "bacteria," or zoogloea formations, which are not seen in living cells save as the smooth crystalline plates. Their true nature therefore can only be demonstrated in fixed material. Iwanowski argues that amoebae could not possibly pass through bacterial filters. He maintains that the amoeboid bodies he found are only reaction products of the cells resulting from the continued irritation by the parasite, namely, the "rod-like bacteria" in the plates.

What seem to have been similar intracellular bodies have been described by Palm as occurring in the cells of tobacco plants affected with mosaic. Palm's account of their occurrence and position in the cells agrees with what I find. He describes these bodies as frequently amoebiform, less frequently round to spherical. In structure they may be decidedly reticulate, or show very little structure at all. He finds there may be one or more cavities in the bodies which resemble vacuoles. He reports the bodies as not seeming to possess any automotive power though they change their position at times by the normal movement of the cell plasm.

Palm accepts Iwanowski's viewpoint as to the character of these amoeboid bodies, and also claims that small "granules" found in the cells of diseased tissue are the organisms responsible for the disease.

In a preliminary report by Rawlins and Johnson on "Cytological Studies on Tobacco Mosaic," these authors associate three different intracellular bodies with the disease. The first, a yellow striated mass of material, is no doubt the result of fixation and the fixing solutions upon the crystals found in fresh material as I have described above. The second type consists

of small bodies about the size of a nucleole. The third, the vacuolate bodies, are no doubt the same as those I find in living and fixed preparations.

The bodies shown in my plate, figure 2, resemble very closely those figured by Kunkel for corn mosaic and drawn from stained and sectioned material, Plate 5, Fig. J. Kunkel describes the intracellular bodies found in mosaic diseased corn tissue as varying in size and form. In their reticulate or granular structure, and the presence of vacuoles, these bodies agree with those I find. The bodies are further described as showing no indication of a membrane, though the author adds that a membrane must be present since when the bodies come in contact with one another they do not fuse. Kunkel observed that the bodies in living material were often moved by the vigorous streaming of the protoplasm but never seemed to move independently or change their shape.

The intracellular bodies figured by Lyon in preparations of sugar cane affected with the Fiji disease, are strikingly similar to those I find. They have the same finely granular content and general appearance of the X bodies I am figuring. They are described as small spherical or oval plasma bodies. The larger bodies may be oblong so as to accommodate themselves to the shape of the cell. Occasionally they may appear lobed or distorted. His drawings were made from fresh material stained with various aniline dyes.

McKinney and his co-workers have described intracellular bodies in living and fixed material associated with the rosette disease and a mosaic-like leaf mottling of wheat. These bodies show considerable resemblance in form, size, and distribution to those described by other investigators of mosaic diseases.

Matz describes the presence of a granular plasmodium-like substance in cells of sugar cane tissue affected with the yellow stripe disease. Such yellow granular material may perhaps be a decomposition product. That the granules exhibit Brownian movement is further proof of such a disorganization in the cells since the contents of dying cells usually show the presence of granules exhibiting such movements.

It is possible that the disease may be transmitted over a limited area by the natural division of growing cells resulting in the formation of daughter cells each containing some of the

bodies present in the original cell. Cells in stained sections of the growing tips show the presence of X bodies in cells containing mitotic nuclear division figures. This, however, could hardly account for the transmission of the disease from the point of infection to distant parts of the same plant.

For instance, I have inoculated young leaves of plants, and two months later have secured severe infections of healthy plants when the juices of the apparently healthy basal leaves of the diseased plants were used as the inoculum. Moreover, the X bodies may be found in tissue from these leaves, although not so abundantly as in the mottled leaves.

It is, of course, at first thought difficult if not impossible to conceive that such bodies as these, assuming they carry the mosaic, can pass through plant tissues as the mosaic virus has been shown to do. In this connection, however, Miehe's observations on migrating nuclei must be kept in mind. Miehe's description of the nuclei of Tradescantia and other cells, passing through the minute pores, Tongl lines, in cell walls has been confirmed by Schürhoff.

These observations certainly suggest also that such plastic bodies as the X bodies in spite of their comparatively large size may very well be able to pass through cell walls and the pores of bacterial filters as the virus has been shown to do. Still such comparisons are not very convincing in the absence of positively known cases of parasites which behave in the fashion suggested. As noted I am reserving for a further paper a fuller account of the behavior of the X bodies in growing points together with a fuller crystallographic account of the numerous bodies which accompany them, in cells suffering from mosaic.

I gratefully acknowledge my indebtedness to Professor R. A. Harper for his many valuable suggestions in this study and in the preparation of this paper.

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Explanation of plate

The drawings were made with the aid of the Abbé camera lucida. A Zeiss microscope was used with a 1/12″ oil immersion objective and a number 3 ocular. The magnification in figures 1, 2, 5, 6, 7, 8 is about 1,200 diameters. Figures 3 and 4 were drawn with the Zeiss objective D and number 3 ocular.

The magnification is about 450 diameters. All the drawings with the exception of figures 7 and 8 are from living preparations. Figures 7 and 8 are drawings from material fixed with Flemming's weak solution, cut at 10μ, and stained with Flemming's triple stain.

FIG. 1. An epidermal cell from a yellowed area on the midrib of a mottled leaf. The nucleus is finely granular and contains three nucleoli. The X body is very densely granular, and contains many vacuoles. Scattered through the cytoplasm are small oval plastids.

FIG. 2. A portion of a hair cell showing five X bodies about the nucleus which lies suspended in the cell by streaming cytoplasmic threads. Two of the bodies show a fine alveolar structure. The other three are granular. Imbedded in the bodies were highly refractive granules.

FIG. 3. A portion of a hair cell showing the distribution of many X bodies of varying size through the vacuole of the cell. Three large and five small bodies are present. Scattered through the cytoplasm are very small oval plastids. The nucleus lies imbedded in the primordial utricle, against the wall.

FIG. 4. A normal hair cell from healthy tissue. The cell contents save for the absence of the X bodies present an exactly similar appearance to that of the diseased cell shown in figure 3.

FIG. 5. A portion of a hair cell in which a single large X body, a crystal and the nucleus of the cell are shown. The X body drawn here shows the appearance of the body when very active and constantly changing its form and position. The small oval bodies are plastids.

FIG. 6. A portion of an epidermal cell of the midrib showing 2 X bodies, and 3 crystals.

FIG. 7. A portion of a cell from a petiole spine of Solanum sculeatissimum affected with tobacco mosaic. The striated body shows the appearance of the crystals after fixation. The nucleus lies against the opposite wall. The X body contains two vacuoles. The striated body and the X body are stained deep orange, the chromatin purple, and the nucleole red. The cytoplasm and cell walls are orange.

FIG. 8. An epidermal cell from the petiole near the growing region of a diseased tobacco plant. This cell contains an elongated striated body, a nucleus, and a large vacuolated X body. In the cytoplasm around the nucleus and the X body were smaller orange stained bodies each containing a single large round vacuole.

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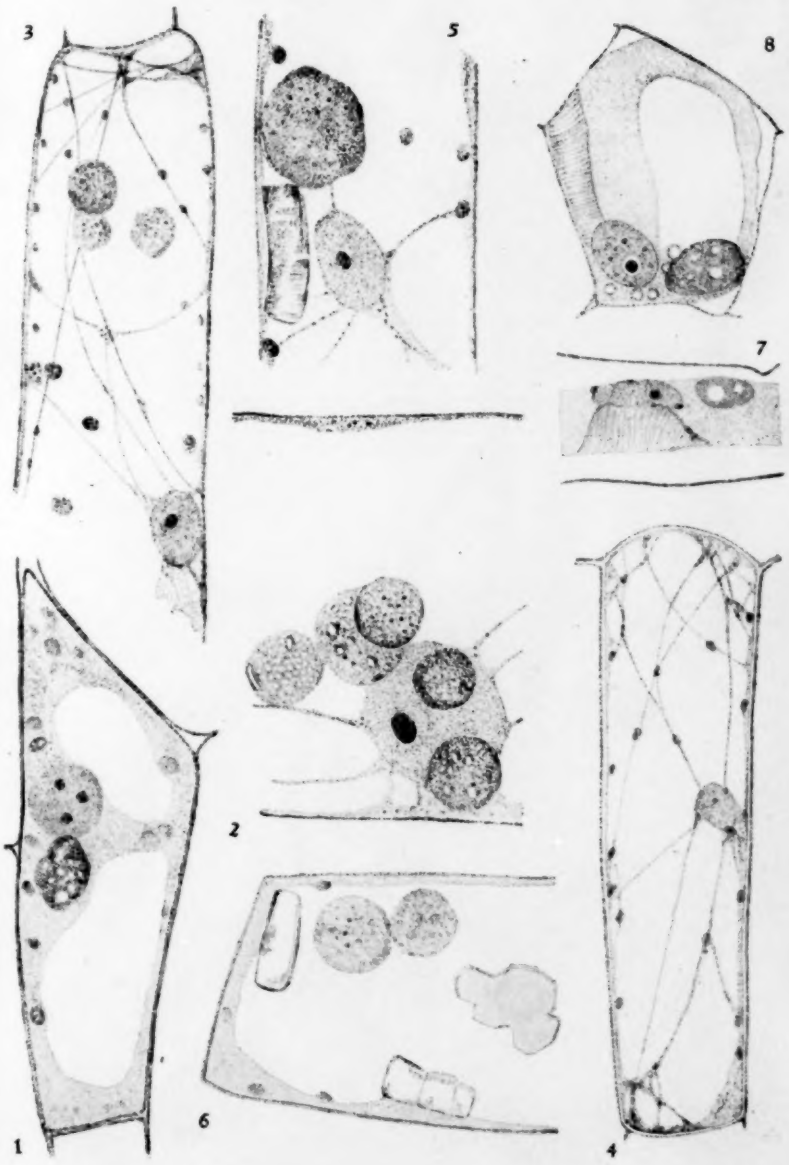
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INDEX TO AMERICAN BOTANICAL LITERATURE

1924

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Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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